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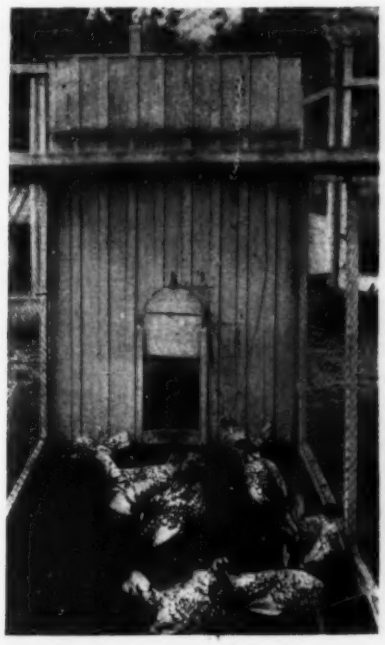
THE FATTENING OF FOWLS IN FRANCE.*

By JACQUES BOYER.

UNTIL a few years ago French poultry raisers confined their attention to setting their hens and giving a little care to the young chicks; but now the farmers of Normandy and Bresse have learned to appreciate the advantages of the method of artificial incubation, which is continually being improved.

Among the types of incubator most popular in France may be mentioned one which consists simply of a cylindrical vessel with double walls of metal, inclosed in a square wooden box. Two glazed sashes, which form the top of the apparatus, allow the successive phases of incubation to be observed. To prevent loss of heat, the space between the metal cylinder and the box is packed tightly with sawdust. The eggs lie on movable trays in the middle of the cylinder. The incubators are placed in rows on benches about sixteen inches high, in a fairly well lighted room where they are not subjected to vibrations.

The eggs, if soiled, are washed carefully before they are placed in the apparatus, the temperature of which,



A PEN OF SILVER BANTAMS.

FAVEROLLES AND BLACK LANGSHANS.

A FRENCH ESTABLISHMENT WHERE FOWLS ARE HATCHED AND FATTENED FOR MARKET.

* From American Homes and Gardens. Published by Munn & Co.

as indicated by the attached thermometer, is kept between 39 deg. and 40 deg. C., by means of a "thermosiphon" regulator heated by a kerosene lamp, which is filled and trimmed night and morning. The moist-

TURKEYS AND GUINEA FOWLS.

ure required for a good hatch is maintained by a bed of moist sand from three-quarters to an inch and one-half thick, on which the eggs rest. There are tubes and cocks for filling and emptying the reservoir, and holes in the bottom of the incubator permit the escape of any excess of water and of the carbonic acid which is produced during the embryonic life of the chicks.

The moist sand is employed in order to prevent the drying and hardening of the soft white membrane which lines the shell of the egg. Without this precaution the chick would not be able to pierce the membrane at the moment of hatching and would die of asphyxiation.

During the entire period of incubation it is necessary, as Mons. C. R. Thomas informs us, in his excellent work, "Les Poussins" ("Chicks"), to "play the hen" ("faire les convenses"); or, in other words, to turn the eggs over and test their temperature and the dampness of the sand every twelve hours.

The attendant reads the theromometer through the glass cover, opens the sashes, takes out the trays of eggs and allows them to cool for fifteen or twenty minutes, during which interval he examines the sand and throws a glass or two of water on it if it seems too dry. Then he turns the eggs and replaces the trays in the incubator. About the fifth day the eggs are tested with the ovoscope, or egg tester, which is merely a little frame with a handle and a pivoted egg cup, and the unfertilized eggs are removed from the apparatus. The instrument is most simple in principle and sufficiently accurate for the purposes in hand. Testing must be done at night or in a dark room. The operator holds the ovoscope in his right hand, brings the egg, with its large end uppermost, very near a gas or candle flame and turns the cup with his thumb. If the egg is fertilized, the embryo, which bears a general resemblance to a red spider, is seen in the interior. If, on the contrary, the egg appears transparent, it has not been fertilized and it must be removed from the incubator, for, if allowed to remain, it would putrefy and vitiate the air breathed by the embryos, to the injury of the health of the chicks.

About the nineteenth day hatching commences and special attention is required. Now the chicks begin to "dig"—that is, to break their shells. From the nineteenth to the twenty-first day, inclusive, the attendant takes care to keep the broken ends free, and in testing the eggs removes, examines, and replaces them as quickly as possible in order to avoid chilling them.

FEEDING GEESE BY MACHINE FOR FOIES GRAS.

The newly hatched chicks are immediately placed in the drier, a square box heated by hot water to a temperature somewhat lower than that of the incubators. Two or three hours' incineration in this temporary prison transforms the slimy and sorry-looking chicks into pretty birds with fluffy silken plumage, bright eyes and lively mien. They run about, seeking seeds and grains, but the attendant is careful to give them no food for twenty-four or thirty-six hours, which interval is needed for the absorption of the yolk, nearly all of which remains in the stomach of the chick.

During the first day the young chicks are placed on the ground for a few minutes every hour, in order that they may take some exercise. After a number of these excursions the poor creatures cry with hunger. They are appeased with a few crumbs of stale bread, but the soft mash which is to form their first regular food is withheld until the third day.

At the same time they are transferred to the brooders, or "artificial mothers," so called. These usually consist of boxes some twenty feet long, covered with glass, and flanked by smaller compartments with solid roofs and walls of wire netting. The brooder is heated by a vessel of hot water which is movable along a slide fixed at the middle of its height, by a thermosiphon, or simply by a lamp which furnishes a current of warm air. The duties of the attendant are to keep the lamp or thermosiphon in order or to renew the hot water daily, to give food and drink to his guests and to keep their apartments scrupulously clean. When the doors of the brooder are opened in the morning the chicks come out into the lateral apartments, eagerly inhale the fresh, cool air, run about, and, if they feel cold, take refuge again in the central apartment, which they enter by a flight of steps.

Their food, which is placed in feeding cups in the center of the cages, is not lacking in variety. Now it consists of hard-boiled eggs chopped fine (yolk, white, and shell together) with stale bread soaked in milk, now of barley or maize flour with chicory, again of grubs, flies or other small insects, raw meat, or boiled rice. Occasionally they receive a dessert of pot cheese, of which they are very fond.

TOULOUSE GEESE AND BARBARY DUCKS.

THE FATTENING OF FOWLS IN FRANCE.

Artificial incubation is equally successful with ducks, which, of all domestic animals, are soonest able to take care of themselves. Geese, on the other hand, are seldom hatched artificially in France. Goslings, like ducklings, appear after twenty-eight or thirty days of incubation, and as they are able to go afield at once they have no need of brooders. Turkeys and guinea fowls are far more difficult to raise. They hatch perfectly in incubators, but become susceptible to disease after what is called "the red crisis" ("la crise rouge"). Then they are put on a stimulating diet, with wine or cider instead of water. Some French poultry farmers devote themselves especially to the sale of eggs for hatching chicks or specimens of pure breeds. In this case the fowls must be carefully kept in separate pens.

Without reviewing all the breeds to be found on French poultry farms I will describe a few of them briefly. The Crèvecœur, a breed of Norman origin, is very common in the west of France. The cock is a splendid creature of pure black plumage, with bluish or greenish metallic luster. The chickens are very precocious and can be fattened for the table in two weeks. Pullets five or six months old weigh six or seven pounds each and their flesh is the finest delicacy of the French markets.

The Houdan, a cross between the Crèvecœur and the Dorking, is a hardy breed of remarkable precocity and fecundity.

The La Flèche resembles the Breda in its majestic carriage. A variety of it which grows and fattens rapidly is sold in the Paris market under the name of Mans pullets.

The Mans poultry farmers highly prize the crested Dutch hen, a good layer though a poor setter, and the

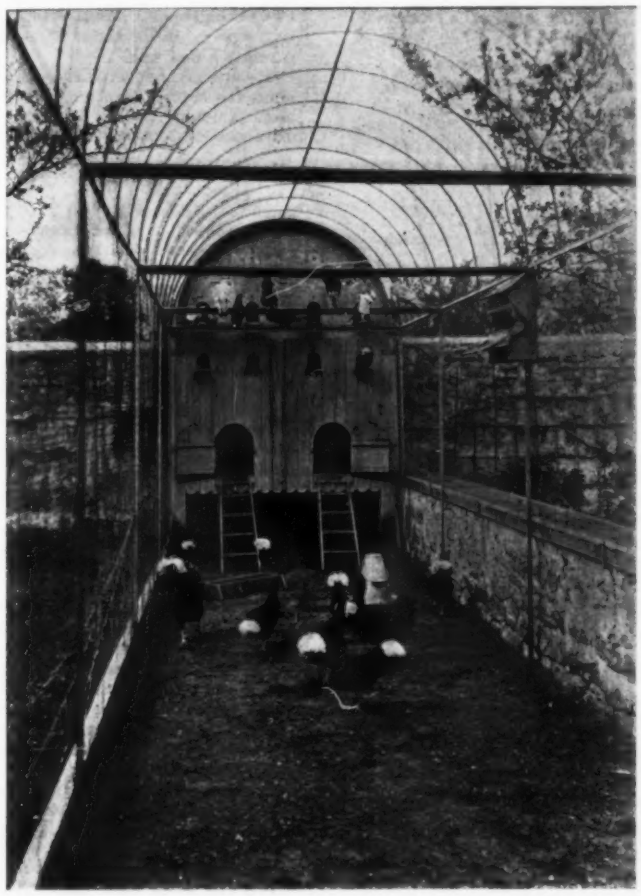
black Langshan, which is a good winter layer and also an excellent mother.

I pass over the choice and carefully bred English game, the Cochin China, of inferior flesh, the Black Spanish, introduced long ago into England, but still little known in France, and the choice fancy breed called the Silver Bantam, and proceed to consider breeds of ducks and geese.

The Aylesbury duck is a serious competitor of the Rouen duck, from which it differs only in color. Its plumage is pure white, its bill a beautiful rose-pink and its flesh delicate and of good flavor. The Aylesbury sometimes attains a weight of ten pounds, while the Labrador duck, which has a short, olive-green bill and glossy black plumage, with beautiful metallic luster on the head, back, and wings, weighs only two or three pounds.

The duck called the Barbotteur ("Dabbler"), which has a greenish-yellow bill, bright green head and neck, a ruddy gray back with fine black and white stripes, and brown wings crossed with bands of velvety blue or black, is a descendant of the wild duck and retains the plumage of its progenitor, modified somewhat by numerous crossings with other breeds. This duck is as widely extended as the common goose, with which it is often found consorting in the ponds of French poultry yards.

The distinctive marks of the Toulouse goose are size, corpulence, a great accumulation of fat under the abdomen and a sort of dewlap, or wattles, at the throat. It furnishes a liver (foie gras) of the highest excellence and reputation.



A PEN OF CRESTED DUTCH FOWLS.

Let us now examine the methods of fattening which are most generally employed. Hand or machine cramming is practised, according to local usage and the size of the flock; but whatever be the method used, the fowls are first placed in dark pens in which they can not move. With this object some farmers merely restrict the space allotted to the birds in a closed poultry house and force them to eat large quantities of easily digestible food. Beginning with boiled and mashed potatoes, they add successively boiled beets mixed with wheat or barley bran, turnips, and cabbage, also cooked and mashed with buckwheat or maize flour. The fattening is completed with chestnut porridge, wet maize flour or such other foods of the kind as are cheaply obtainable in the respective localities, potatoes being always given in the morning as an aperient.

After two weeks of such fare our "Gargantuas" are ready to begin the last part of their agony, in which the extraordinary enlargement of the liver is accomplished. The fowls are confined in special cages called épinettes, some of which hold as many as twelve birds. There are also circular épinettes, which accommodate two or three hundred fowls. In these narrow stalls the poor creatures can move about, but they cannot stand erect. They are fed in the following manner: The attendant fills the pump of the feeding machine with soft food and raises the piston to the top of the barrel. An iron weight attached to a cord (concealed by the machine in the illustration) exerts a pressure on the valve which expels the semiliquid contents through a rubber tube which terminates in a nozzle. The feeder lifts the patient's head and opens its bill with his left hand, and with his right inserts the nozzle into the bird's throat.

In this way the required ration is administered to each fowl in succession. All kinds of domestic fowls are fattened by this method, but it is used principally for ducks and geese, which become ready for the table in two weeks. According to the calculations of experienced poultry farmers the fattening of a young bird costs thirty cents and adds sixty cents to its value—which is a very pretty profit. The operation, however, must be stopped at the proper point, for it is possible to fatten fowls to death.

In Normandy and in the vicinity of Toulouse food is often administered through a funnel with a tube large enough to permit the passage of whole maize boiled in salt water. Three times a day a man takes each bird in succession between his knees, introduces the end of the funnel into its mouth and pours in the paste with a spoon, after which he offers his unhappy guest a drink.

Boiled potatoes, or barley or buckwheat flour mixed with curdled milk are sometimes substituted for the whole corn. These foods are made up into pellets, which the feeder, with his right hand, forces into the gullets of the patient, after opening the bill with the index finger of the left hand.

The very primitive method of feeding known as "billing" is now almost entirely obsolete. The feeder filled his mouth with the semi-liquid paste and applied his lips to the mouth of the bird. This very unappetizing practice required a special lingual dexterity which was very difficult of acquisition.

AN INCUBATOR ROOM IN A FRENCH ESTABLISHMENT. THE WALLS ARE STUDDED WITH PRIZES FOR EXHIBITS OF FOWLS AND PATÉS DE FOIES GRAS, WON AT FAIRS.

FEEDING BY HAND WITH SOFT FOOD, AFTER WHICH THE FOWL IS GIVEN A DRINK.

THE FATTENING OF FOWLS IN FRANCE.

Constant vigilance is necessary to prevent the introduction into the United States of birds or animals that are likely to become pests. No species, therefore, except a few that are well known and harmless, are allowed to enter this country without a special permit from the Department of Agriculture. And, as an additional safeguard, careful inspection is made whenever through the large size of the consignment or other cause there is any apparent danger that undesirable species may slip in. The permits issued during the year numbered 318 and allowed the entry of 1,470 mammals, 205,400 canaries, and 41,630 miscellaneous birds. Most of the canaries and a large part of the miscellaneous birds came in at New York and were examined by inspectors at that port. Several importations were made of birds intended for liberation, among them 65 capercailzie from Sweden, brought in at New York and destined for the stocking of Algonquin Park, Ontario; 40 Mexican quail, liberated at various points in California by the board of fish commissioners of that State; and 366 European song-birds—goldfinches, bullfinches, larks, and robins—turned loose in British Columbia. Permits were also issued for the entry of about 3,000 eggs of partridges and pheasants.

Correspondence.

AERONAUTICAL COMMENT.

To the Editor of the SCIENTIFIC AMERICAN:

My attention has been directed to an illustrated article on the interesting experiments of the well-known French aeronauts, Messrs. Louis Goddard and Felix Faure, on the lifting power of a screw propeller for aeronautical work in your issue of December 9, 1905.

In this article you were good enough to refer to these tests and the apparatus employed—called by them the "Autovolant"—as constructed on somewhat the same plan as that outlined by me in an article in SUPPLEMENT No. 1399. Barring detail of construction, and method of operation to attain commercial results, broadly, one would be warranted, I think, in saying they are precisely on the lines outlined by the undersigned; and further, proved by actual test what I sought in several articles to prove, and, as it turns out, did prove, with empirical and other data. If you will go further back, to August 11, 1894, in SUPPLEMENT No. 971, you will find there the "flapping movement to the blades"—that is to say, a beating thrust combined and simultaneous with a rotary thrust in a screw propeller for aeronautical work; or, as I then put it, "a two-fold motion of pendulation and translation is imparted to aeroplanes disposed in such a way that power can be effectively applied"—illustrated by the writer in an article entitled "An Analysis of the Function of a Bird's Wing During Flight and its Mechanical Imitation." In another publication of subsequent date (Electrical World, June 20, 1896) the subject was further and more fully treated. And again, if you will refer to a letter in SUPPLEMENT No. 1465 (January 30, 1904) and the figures therein given in support of my arguments (i.e., the numerical results of individual and governmental investigations in screw efficiencies), you will find that the figures, when summed and averaged—eliminating fractions—give precisely the figures attained by Messrs. Goddard and Faure, viz., $66.13 \div 1.75 = 37$ pounds thrust per horse-power output. I will venture a prediction that these results, which only duplicate what has been done many times in the history of the art, will probably be found twice sufficient to make a practical navigator of the air when the best available ways and means are employed. Apropos, as our neighbors across the sea seemingly have facilities galore to do things which subsequently we must needs import or imitate, let me state another (but unillustrated) idea in the form of a question, viz.: Can an aerial screw propeller revolving on a vertical spindle be made to move itself horizontally in the air?

The Prince of Monaco has recently built at Monte Carlo a small machine which they call a "Helicopter." The name is not familiar here as yet, and substantially the structure, as also the proposed way of operating it, is very old in this country—at least ten years. He is reported to have a model weighing 187 pounds which gives a fulcrum on the air, we are told, of 220 pounds. A machine of double the size is under construction, and of it we are informed (Harper's Weekly, September 23, 1905) that "the full-sized machine will raise eight times as much as the half-size model, and as the latter can raise 220 pounds, the full size will lift 1,760 pounds. This is not supposition, but as certain as that twice two makes four." His Highness then continues: "A 100-horse-power motor, with the petroleum for an hour's work, we may therefore calculate at 440 pounds, and allowing 165 pounds for the weight of the aeronaut, we have still the very respectable balance of 1,155 pounds of loading power at our disposal." Now, if Prince Albert will kindly include the weight of his machine in his calculations, and when he enlarges its size increase also its weight proportionately as the *cube* of the increased dimensions; or, to put it differently, when he doubles its size, multiply the weight (187 pounds) by 8 and then add the weight of the operator and the engine $(1,496 + 165 + 440 = 2,101$ pounds) he will then see that his figure for contingent load (1,155 pounds) becomes a negative quantity to the extent of 946 pounds, and that his machine, with an initial lift of 1,760 pounds, will require an additional lift of more than 341 pounds to rise from the ground.

Passaic, N. J., December 14, 1905. S. D. MOTT.

AN ILLUSTRATION OF THE STATEMENT THAT $x^0 = 1$.

To the Editor of the SCIENTIFIC AMERICAN:

WILL you kindly answer for me the following:

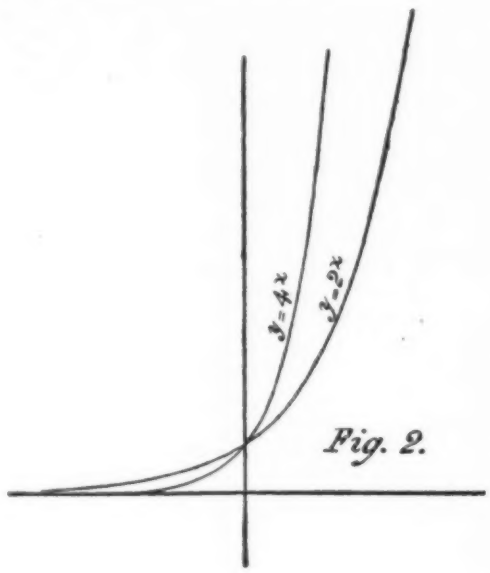


Fig. 2.

"Trace the variations of the curve $y = x^n$, as n varies between $+\infty$ and $-\infty$ It affords a beautiful illustration of the meaning of the statement that $x^0 = 1$."

I have plotted for different values of n, but am unable to deduce therefrom that $x^0 = 1$. How is this done? W. F. WRIGHT.

Washington, D. C.

REPLY.—In Fig. 1 of the accompanying diagrams all curves of the form $y = x^{2n} + 1$ have the form of No. 1 lying in quadrants 1 and 3. All curves of the form $y = x^{2n}$ have the form of No. 2 lying in quadrants 1 and 2. As $n \doteq \infty$ both curves flatten, No. 1 approaching a right-line figure composed of the positive end of the line, whose quotation is $x = 1$, the portion of the X axis from $x = 1$ to $x = -1$, and the negative portion of the line $x = -1$. Curve No. 2 approaches a curve made up of the first two lines above, and the positive end of the line $x = -1$.

If $n \doteq 1$, the curve approaches No. 3, a 45-deg. line through the origin. Curves Nos. 4 and 5 are examples of graphs of the function $y = x^n$, where n lies between unity and zero. Those having even denominators become imaginary for negative values of x.

If $n \doteq 0$, the curve approaches a right-line figure composed of the positive end of the line $y = 1$, the Y axis from the point $y = 1$, to the point $y = -1$, and the negative end of the line $y = -1$, which we call curve No. 6. No. 7 is a curve where the exponent lies between 0 and -1 and is even. The other branch is imaginary. With an even exponent between 0 and -1 there will be a branch also in the third quadrant. It is manifest that if in the equation $y \doteq x^n$, $n \doteq 0$, for positive values of x, $y = 1$. A very interesting result comes from the study of the curve for negative values of x. As $n \doteq 0$, y approaches -1. It is usual to define the zero power of a quantity positive or negative as equal to unity. So far as the writer is aware, no one has defined the zero power of a negative number as minus 1. The particular result called for is more readily seen from an inspection of Fig. 2, where the function $y = a^x$, is plotted. The symbol ($\doteq$) which is used a number of times, an equality sign with a dot above, means "approaches as a limit." The fact that $(-a)^n$ approaches *minus* 1 as a limit instead of plus 1 is likely to excite some comment, as the idea is apparently a new one.

We are favored with the above solution (which extends the subject into a region which has not hitherto been explored) by Mr. L. Leland Locke, instructor in mathematics, Adelphi College, Brooklyn, N. Y.—EDITOR.

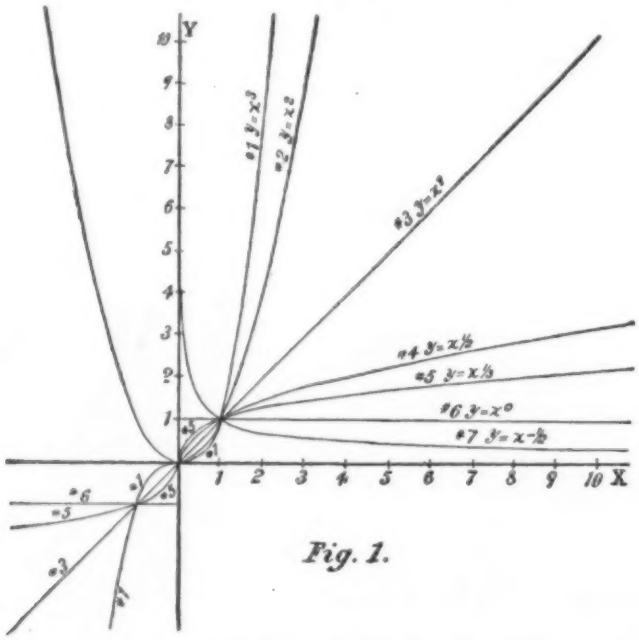


Fig. 1.

BOILER COMPOUNDS.*

By JOHN C. SPARKS.

THE subject of boiler compounds to be used for making water more desirable for boiler feed purposes is one that is largely a matter of personal opinion and experience.

The general idea underlying the whole question is the removal of hard and soft scale which, in waters containing a relatively large amount of carbonates and sulphates of calcium and magnesium, would form a scale in the boilers and cut down the efficiency of the boilers by forming partial insulation from the source of heat.

In some waters having an acid reaction a boiler compound is added to prevent the pitting and corrosion of the iron and therefore to lengthen the life of the boiler.

The various boiler compounds on the market may be divided into two general classes: First, inorganic or mineral compounds; and second, organic compounds such as tannates, etc.

As is very well known, the general idea of the efficiency of a boiler compound is that it shall combine with the free carbonic acid present in the water and so precipitate the carbonates of calcium and magnesium, which are only soluble in water containing carbonic acid; that is, they are only soluble in the bi-carbonate form. The secondary reaction is that the sulphates of calcium and magnesium shall be changed to the insoluble carbonates of the same elements and therefore precipitated. All these precipitates are from time to time blown out of the boiler and so gotten rid of. Free mineral or organic acidity is neutralized with an alkali and the action of the acids prevented.

It must be understood that any system of water softening for boiler feed purposes is merely the substitution of a relatively less harmful substance to take the place of a relatively more harmful substance which is eliminated in the form of a precipitate.

It is therefore necessary that the exact amount of the boiler compound, no matter what that boiler compound is, shall be added to the boiler feed water so that there is not an appreciable excess of the boiler compound, as too much of this would have bad effects in the boiler.

It is therefore necessary that the user of water for making steam in his boiler shall know what his feed water contains and keep a check on the amount of the boiler compound he adds to the water.

I am a great believer in simple factory tests being applied, and one can easily educate an operating engineer so that he can perform all the tests necessary. In the case of alkaline mineral boiler compounds, which make up at least 80 per cent of the boiler compounds extensively used, too much of the boiler compound present in the boiler will cause the boiler to prime.

Everyone knows exactly what priming is, and it is caused by the surface tension and limit of elasticity of the water being so increased that it will hold vapor under a greater pressure, and in plain English this means that the water will foam and some of the water in the boiler will be carried over with the steam.

An ordinary application of this fact is that a drop of pure water does not have sufficient tension to enable much air to be inclosed in it; but if that surface tension and elasticity are increased this is quickly possible. The small boy, when he blows soap bubbles, adds the soap to the water to increase the surface tension and elasticity, to enable the water to have enough surface tension to inclose a relatively large amount of air. If you asked him he probably would not know this, but he does know that he cannot blow bubbles with water without soap, though perhaps he might use certain boiler compounds to produce the same effect.

It is therefore important that there shall not be too much boiler compound used, and although hard and fast rules may be laid down as to exactly the amount of boiler compound to be used for this specific water under consideration, yet the engineer at the plant should occasionally make some simple tests.

The best test when using alkaline compounds is to run some of the water from the boiler into an ordinary tumbler and add to it a few drops of phenolphthalein which reagent is milky white in the presence of acids and bright crimson red in the presence of alkalies. Supposing he does this and finds the color changed immediately to a bright red. He should cut down his supply of the boiler compound till on repeated repetition of this experiment the color produced is a pale pink, showing only a trace of alkalies present.

One of the most harmful ingredients present in water is the chloride of magnesium. This salt in the presence of heated iron liberates free muriatic acid which has a violent corrosive effect on the boiler.

The next most harmful salts are sulphate of magnesium and sulphate of calcium, both of which form hard scale; then carbonate of magnesium and carbon-

*Read before the Society of Refrigerating Engineers.

ate of calcium, both of which form soft scale; and also, of course, any free acidity, or common salt that may be in individual waters but which are only occasionally met with.

I cannot lay too much stress on the subject of priming in boilers.

Everyone knows the general effect of wet steam instead of dry steam in the engine; and the appearance of ice made from water where the boiler has primed is very marked indeed. Anyone at all familiar with the appearance of ice under various conditions can readily detect the mantle of opaque ice that alkaline salts cause in can ice, and it is a very great detriment to the ice made.

There are many good boiler compounds in the market, most of them being composed of alkaline carbonates, borates, phosphates, etc., in various proportions, and there is a tri-sodium phosphate of which you all know and then there are many organic compounds, all of which are based on tannates.

I have found that most of these boiler compounds if properly administered will do all that is claimed for them, and I have also found that in most cases the boiler compound is improperly applied in regard to quantity.

I am not referring to the water-purifying apparatus and devices, but to the straight addition of boiler compound to the water in the boiler.

I personally prefer mineral boiler compounds to organic ones, especially in waters containing a large amount of sulphates.

It is rather difficult to lay down any hard and fast rules as to when a plant should use a boiler compound, but if the total hardness of a boiler feed water should be anything over 8 deg. of hardness according to the United States standard the water requires a boiler compound; also, it is necessary that engineers be instructed when using boiler compounds to blow out the boiler at frequent intervals so that the precipitated salts are blown out of the boiler and do not accumulate.

A NOVEL TYPE OF GAS PRODUCER.

IN a type of gas producer constructed according to the Jahns patents by the Union Machine Works, of Essen-Ruhr, the influence of the unsatisfactory initial stage is eliminated by leading the unsatisfactory gases into the incandescent charge of another generator chamber in a condition of pure gasification, there to be converted into available gas. An uninterrupted uniform operation is insured by so combining several compartments in an annular arrangement that at least one of the chambers will absorb the gases from the other preparatory chambers. After the latter has been exhausted to a certain extent, the preceding compartment is substituted for it, and so on continually in a cyclic process. The operation thus goes on without any interruption due to the charging of fuel and discharging of slag.

The new generator proves especially valuable in connection with bituminous coal and low-grade fuel. Another feature is the absence of any smoke nuisance and the obtaining of a bright gas fire free from any soot, which will be found useful for many industrial purposes.

As regards the arrangement of the annular generator, channels have been provided between the various compartments, of which the larger plants contain several annular sets. The simplest arrangement is that of a twin generator including only two generator compartments. The upper parts of the latter are alternately connected with the lower parts by two interlocking channels, into each of which a steam-jet blower has been fitted. Each compartment is connected with the general suction pipe, from which it may be cut off, while locked underneath by a stationary or movable grating.

The walls of the generators are lined with a sheet metal sheath and an insulating layer impervious to the air and heat, while the inner masonry consists of air-tight fireproof bricks. The charging and discharging openings in the tops of the compartments are formed of cast-iron domes, carrying lateral pipes connected with the gas-collecting pipes. The latter communicate with a suction device producing the depression in the generators for drawing in the combustion air in conjunction with the blower in the central channel.

A plant recently constructed by the Union Machine Works is designed for a daily output of 180,000 to 200,000 cubic meters of gas, which, however, in the case of high-grade coal, can be increased up to 900,000 to 1,000,000 cubic meters.

ARMORED CONCRETE.—I.*

By Lieut. HENRY J. JONES, A.O.D., A.R.C.Sc. (Lond.), Inspector of Ordnance Machinery.

OF the interesting features of modern constructive practice which call for appraisement, either from their extreme novelty or successful application, none holds so high a place as the unique adaptability of armored concrete to the many and varied engineering requirements of recent times.

The term "armored concrete construction" is used to denote any general scheme of construction in which a combination of concrete and steel is made to do duty more economically than would either steel or concrete if used alone; and in the discussion of economy we shall be led to include, not only initial cost, but also cost of maintenance, rate of depreciation, standard of labor, and rapidity of construction. With regard to the economy in initial cost of materials, and also in illustration of the striking influence of steel armoring used in the way to be hereafter explained, attention may be drawn to Fig. 1, which shows two beams designed to carry ordinary floor loads, the one made entirely of concrete, and the other of concrete with a sheet of expanded metal imbedded in the tensile portion of the beam. The saving in mere weight of concrete alone is most striking; and when we remember that the adoption of floor beams entirely of concrete means an increase in thickness of nine inches, or supposing five to eight floors, an increase in the total height of the building (with extra cost of higher and heavier walls, together with heavier foundations to carry them), of from four to six feet, we see that even

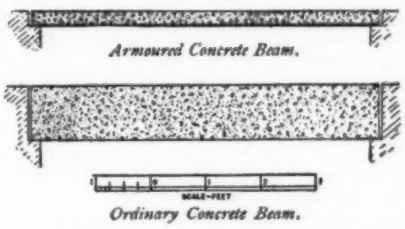


FIG. 1.—BEAMS, OF EQUAL STRENGTH, OF ARMORED AND ORDINARY CONCRETE.

as regards initial outlay for materials, the introduction of steel armoring into concrete construction is of great importance. When we shall have considered the other items on our economic programme, the fact that armored concrete construction is incomparably the best system at present known to engineers will be even more manifest. The most remarkable fact about the whole matter is, that the weight of properly disposed steel required to reduce the depth of our floor beam to one of equal strength in armored concrete, is so insignificant. Comparing areas of steel and concrete exposed in cross-section, the steel is sometimes only ½ per cent, and rarely rises above 1 or 1½ per cent of the area of the concrete; and as the cost of expanded metal is only from 2s. 5d. to 1s. per yard super, we see that the cost of the steel armoring is very small compared with the saving in weight of concrete which it produces.

Subsequently we shall treat of the systems and methods of calculation in detail; but a good idea of armored concrete construction can be obtained from Fig. 2, which is an isometrical projection of a portion of a pier strong enough to carry the heaviest railway traffic. The disposition of the steel work is shown in the piles, the main girders, and beams; and the manner in which the steel rods running along the tensile or bottom side of the girders and beams are bent up over the top of the pile, which is here the tensile member (the beams being continuous), and then down again to the bottom of the girders and beams, is most instructive.

The use of armored concrete as a material of construction has much to recommend it. The materials can be cheaply procured and transported, and can be adapted to almost any conditions, being suitable for floors and beams, piles and tunnels, pipes and aqueducts, reservoirs and bridges. Armored concrete possesses excellent fire-resisting properties, is as economical in almost any neighborhood as bricks and mortar, and besides combining strength with durability, is able to resist the action of rain, frost, and smoke; in a general way it may be dealt with by local and unskilled labor, although a considerable amount of skill in handling contractor's plant, as well as a high standard of carpentry, are required for the temporary work of erection. A structure in armored concrete needs no expenditure for maintenance, and thus has a great advantage over steel work, which requires to be painted every few years to prevent rapid deterioration. For

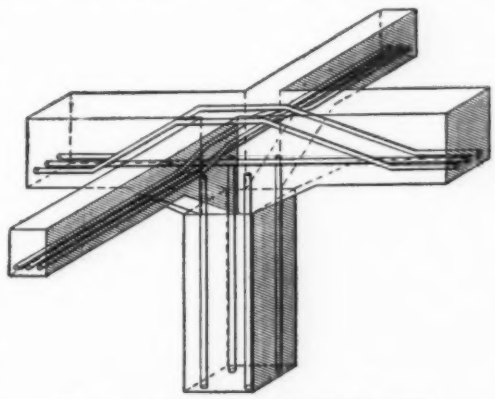


FIG. 2.—ARMORED CONCRETE PIER.

sea structures, armored concrete is far superior to either wood or steel, and less costly than stone. It does not suffer from the ravages of the marine pests, *Teredo navalis*, *Chelura terebrans*, and *Limnoria terebrans*, and there is no need to use corrosive sublimate, chloride of zinc, or creosote for protective purposes.

Labor in armored concrete is cheaper and more expeditious than that in steel, for steel rods or expanded metal are easily obtained, and concrete quickly prepared; whereas to obtain special castings in steel is a costly and laborious process, necessitating highly skilled workmen, and a loss of available section due to riveting. A girder in armored concrete can be made and fixed in position before steel girders would be half finished; and warehouses of seven and eight floors, supported by armored concrete girders and columns, have been erected in a few months, whereas it would have taken three times as long to erect a similar building in the usual manner with steel girders and columns. Bridges built of armored concrete admit of very flat arches, which would be impossible in brick and stone, and thus we are able to secure the advantage of greater waterway compared with arches of the same rise. Pipes and conduits can be made *in situ*, to any length, diameter, and section, being strong enough to carry the heaviest vehicular traffic, and comparing favorably in price with similar work in brick and stone.

Armored concrete structures are, for the same strength, lighter than those in masonry and stiffer than those in steel, and in general the adoption of armored concrete means a saving of from 15 to 20 per cent on the initial outlay, and a further saving due to the permanence of the work and its insignificant need for maintenance.

Previous to the invention of Portland cement by one "Joseph Aspdin, bricklayer of Leeds, in the County of York," powerful and quick-setting limes were unknown, and concrete manufacture was restricted to the use of materials corresponding to the old Roman *pozzuolana*, although of totally different origin. Added to this absence of a suitable matrix, there was also an entire absence of any mechanical appliances to facilitate construction, and to reduce the aggregate employed to a suitable size. Hence it came about that in this country concrete construction was almost entirely abandoned, and foundation work came to be done by the costly system of piling and planking. With the introduction and extensive manufacture of Portland cement, as well as mechanical crushers for reducing the aggregate, we might have expected concrete construction once more to have found favor and adoption. It was not so. Engineers found concrete a very uncertain material to deal with. It would fail suddenly under transverse strains, and thus its use, when tensile strains had to be borne, became a matter of great difficulty and no little danger, because, to insure sufficient safety, great depth had to be given to beams and floors, which added considerably to the total weight and cost, and to the height of the structure. Subsequent experience and experiment established the fact that the strength of concrete in tension is only about one-tenth its strength in compression, which could reasonably have been expected when we remember that in tension we depend for our strength mostly on the tensile strength of the matrix, which is low, and in compression on the compressive strength of the aggregate, which is high.

Hence arose the question, In what way can we treat concrete so that its high compressive strength can be utilized without, at the same time, placing any reliance on its low tensile strength? The problem was first solved, accidentally, by Jean Monier, a gardener of Paris, who in 1876 invented the system of construction which has since been known by his name. Ward, of New York, had, however, previously (in 1875) constructed a building in which, "not only all the external walls, cornices, and towers were constructed of cement concrete, but all the beams and roofs were exclusively made of it, reinforced by light iron beams and rods." The introduction of steel into concrete was thus found to give, indirectly, the quality which the concrete lacked in itself; and such an introduction has its warrant in the fact that concrete construction without a tension member can be used only in a limited number of cases where economy in weight and cost do not enter as controlling factors.

In a general way we may take it to be axiomatic that economic structural design aims at such a distribution of forces, and members disposed to bear them, that, under the conditions of greatest allowable strain, each member or portion of a member shall bear just such a force as that for which it is best fitted, all members shall be stressed to their safe limit at the same time, and the cost of the structure shall be a minimum consistent with the other conditions being satisfied. Armored concrete construction is eminently in accordance with these principles.

Experiment has shown that the compressive strength of concrete is about ten times its tensile strength, and that steel has about the same strength in tension and compression. A given volume of steel costs about fifty times as much as the same volume of concrete, and for the same sectional area steel will bear in compression thirty times the load borne by concrete in compression, and three hundred times the load borne by concrete in tension. Hence, for duty under compression only, concrete will carry a given load at six-tenths the cost required to support it in steel. On the other hand, to carry a given load by concrete in tension would cost six times as much as to support it with steel. Hence if we endeavor to arrange the members of our structures in such a way that the compressive stresses are all borne by the concrete, and the tensile stresses by steel suitably imbedded in the concrete, we shall be using each material for the purpose for which it is the cheapest and the best fitted, and thus fulfill the above-stated principle of economic design. It may be stated here, that the shearing resistance of concrete is also very inadequate, and hence in the most approved armored concrete designs, the shearing stresses are borne by small steel rods and stirrups imbedded in the concrete.

Having satisfied ourselves that the novel combination of steel in concrete is, theoretically, a justifiable

* Technics.

one, the question naturally arises as to the effects of age, moisture, changes of temperature, on the mutual relations between the steel and the concrete. Is the adhesion between the two materials such as to prevent slip when distortion takes place? Will water, percolating through the concrete (a substance not impervious to it) cause the steel to rust and deteriorate? Will the combination stand shock, the effect of rolling loads, and the changes of temperature, both natural and artificial, without permanent injury and decay? To all these questions practice gives a positive and favorable answer.

With regard to adhesion, it may be noticed that the force required to separate a rod from the concrete in which it has been imbedded varies from 550 to 650 pounds per square inch. Since this is above the figure assumed for the safe working limit of concrete in compression, no fear of failure through slip occurring between steel and concrete need be entertained. The use of expanded metal and twisted rods offers a better means of securing a good adhesion than the use of flat bars or round rods. As far as experience goes, steel imbedded in a good alkaline concrete will not rust in any way when exposed to the action of moisture and air; at any rate, if there is a deteriorating action, its extreme slowness does not enter as an objection against the use of steel armoring. Again, no disintegration of the concrete occurs under severe shock or the most violent changes of temperature. Piles of armored concrete, up to 60 feet in length, have been driven and withdrawn without any injury whatever. And the result of experiment and experience on armored concrete work has been to show that the coefficient of expansion of steel and concrete are almost identical, and independent practically of the proportion of cement used. The expansion of such structures must, however, be provided for, in order to prevent undue strains and subsequent surface cracks. In this connection rich concretes are not recommended, as they crack more readily than concretes of poorer composition. It is further advisable to cover the concrete where possible, and to provide expansion joints, as well as avoiding sharp angles and fixed beam ends where free ones could be as suitably employed. Slow-setting cement of good quality is imperative, and the main thing about the concrete is not so much its composition as the care with which it is made, applied, and rammed, when once the materials have been chosen. The only objection to the armored concrete is an æsthetic one. The appearance of the finished work is dull and colorless, without any of the distinctive tones and color which we have usually associated with engineering work in brick and stone, especially when the work has been of a high standard. But in circumstances where appearance is an inconsiderable quantity, for piers, jetties, foundations, etc., armored concrete construction has claims very far in advance of any material now at the disposal of the constructional engineer.

(To be continued.)

A PERTINACIOUS CURRENT; OR, THE STORAGE OF HIGH-TENSION ELECTRICITY BY MEANS OF VALVES.*

By SIR OLIVER LODGE, LL.D., D.Sc., F.R.S., M.R.I., Principal of the University of Birmingham.

IT is well known to physicists and engineers that currents of electricity can be of three principal varieties. The first and oldest variety is a continuous or steady current, of constant strength in one direction, like a river. By such a current a great quantity of electricity can be conveyed from place to place, though under conditions that it is easily stopped by any trivial obstacle, either an accidental bad joint or a purposed switch or interrupter—which is a familiar arrangement for introducing into the stream an air-gap or other narrow non-conducting obstruction, and thereby completely stopping the flow, save at the first moment of attempted stoppage, when the impetus or momentum of the current succeeds for an instant in bursting through the obstacle, with spark and flame.

The second variety is an intermittent or jerky current; which is analogous to the supply of water by an ordinary intermittent pump, such as a fire-engine or a garden-engine without its air-chamber, from whose nozzle the water issues in jerks, unless there is some elastic reservoir or chamber of variable capacity in which it can be stored under pressure, and out of which it can emerge with fair regularity.

The third variety is the important case of the well-known "alternating current," wherein there is no progression of electricity at all, but simply a surging or oscillation to and fro, maintained by a rapidly reversed force of propulsion, such as is seldom applied to liquids; though it is applied to solids in many forms of reciprocating machine, and in several other oscillating or vibratory examples, of which the best-known variety is concerned with musical instruments. An alternating current of liquid, however, occurs in nature, on a large and slow scale, in the tides; and it may be set up on a small scale in a churn.

An alternating electric current is characteristically produced by nearly all the magnetic methods of exciting a current discovered by Faraday, i. e., by those methods which generate a current by means of a combination of magnetism and motion, as exemplified in the ordinary dynamo. It is true that these currents can be rectified, and so transmitted in one direction over a portion of the circuit, by means of some kind of commutator; but such an arrangement never operates over the *whole* of the circuit; there is nearly always one part of the circuit, and that the generating part, where the quantity of electricity oscillates equally to and fro. The so-called "unipolar" machines are an exception. It is, however, possible to interpose something in the path of an alternating current so as to prevent the passage one way and permit it the other, that is to say, to introduce into the circuit a one-sided kind of conductivity, such as is possessed by a trap or valve, which permits ingress but prevents egress—a kind of gate, such as is sometimes used for public gardens or parks, whereby people can go out but not come in. Or like a mouse-trap, which lets creatures in but will not let them out.

If such an arrangement exists in an alternating-current circuit, it changes the current into an intermittent or jerky one, with the progress either wholly in one direction or more in one direction than in the opposite. Such an arrangement may be conveniently called an electrical *valve* or *trap*. By the use of such valves I have found it possible to store up electricity, supplied by intermittent jerks, in a reservoir, until the tension is raised to a high value; and it can then be allowed to leak or overflow in a constant continuous stream or trickle, which, though not transmitting a very large quantity of electricity, can nevertheless overcome very considerable obstacles, pertinaciously flowing in spite of opposition, like a stream down a steep hillside. This is what I call for the moment a pertinacious current. It could always be produced by means of an electrostatic machine—either the old-fashioned frictional machine, or a Holtz or Wimshurst inductive machine—and about the pertinacity of such a current there was no dispute; but unless such machine were of enormous size, the quantity propelled was very small, and the current was essentially a weak one. Moreover the generating machine was necessarily of a delicate laboratory description, such as could hardly be regarded as appropriate for engineering practice on a large scale.

It has been always theoretically possible also to produce a high-tension or pertinacious current by means of a voltaic battery of an enormous number of cells; and by some experimenters, such as De la Rue and others, a battery of this kind was actually employed. In the case of a voltaic battery the quantity put in motion is considerable, but the difficulty was to raise the propelling force to the required amount—usually it is very weak; and in order to imitate such effects as are easily producible by a large Wimshurst machine, some considerable fraction of a million would be the number of cells necessary. The expense and trouble of such a battery would be prohibitory to most people, and to most undertakings; especially since the cells have but a temporary and rather brief life.

By the use of electric valves, however, I find it possible to employ a current generated by mechanical and magnetic means, to convert it into an intermittent current at very high pressure, and then to store the quantity thus propelled in reservoirs supplied with valves which prevent the flow back; so that the whole quantity transmitted in successive impulses accumulates, until the reservoir becomes full and overfull, so that it overflows, giving a steady stream or trickle through great resistances, and maintaining the continuous high-tension current required. It is as if a reservoir were being charged by a water-ram, or by waves which splash up into it through a hole, the hole being provided with a valve whereby the water supplied is trapped and not allowed to flow back again each time in futile manner, but is kept stored and accumulated until the pressure has increased to an enormous extent: the process is, in fact, exactly like pumping air through a valve into a closed reservoir, by intermittent strokes of a pump, and then allowing the reservoir to leak through a small hole, as soon as the pressure has become sufficient.

On the plan customarily used for obtaining Leyden-jar sparks in spectrum analysis, etc., the jar is charged at every break of the coil, but the charge immediately subsides through the wire of the coil, and so the jar is perfectly empty in a minute fraction of a second after the discharging impulse; accordingly unless the overflow spark occurs instantaneously it will not occur at all. There is no accumulation of impulses, and only a short spark can be obtained. But when a valve is inserted, then the charges do not sink back through the generating coil, but accumulate, and the overflow spark length now may be very much greater.

The chief use to which I wished to apply this arrangement was to the dissipation of fog or smoke, or the deposition of metallic fume, and the principle of that application is shown by attaching to the jar a wire which leads to a point immersed in some fog or smoke in a bell jar or other vessel; and now, by a momentary excitation of the coil, the jar or reservoir is filled up to bursting-point with electricity, which at this high pressure continues to discharge or fizz from the point for some time, say ten seconds or thereabouts, by which time the fog has completely disappeared.

In order to fill a vessel with an atmosphere of fog or smoke, almost any plan serves; one way is to burn smoldering brown paper, but that is not at all a good plan, since the smoke is not dense, and being hot it hovers about at the top; another is to burn tobacco, which does better; in fact, very fairly well; another plan is to burn magnesium wire, which is a cleanly and good method, and the smoke being solid and white, it illustrates the process of dissipation very well; another is to make a chemical smoke by the use of hydrochloric acid and ammonia, or by burning sulphur in an ammonia atmosphere; indeed, there are plenty of plans known to chemists; but the method I prefer for the present purpose is to make artificially a mist or fog of water vapor. It may, for instance, be composed of clean steam blown from a boiler into a bell jar or globe, so as to make a cloud, or clean country mist; and in that case when the point is electrified the drops are seen to coalesce, and therefore rapidly to grow in size, under the action of the electricity, until it becomes a Scotch mist or fine rain, too heavy for suspension, and so rapidly falls as it does in nature. Or the air of the jar may be rendered foul beforehand with dust or other impurity, or it may be contaminated with burnt sulphur, before admitting the steam, so as to imitate the effect of water-vapor mingled with the products of the combustion of coal; and then the country mist becomes a town fog—thick, dense, and yellow; but the electricity clears it just the same.

Instead of blowing steam in from a boiler, the moisture of the atmosphere itself may be used in the following way: Take a large glass globe with a bottle neck, fit the neck with a plug through which a tube passes leading to a compression pump, such as a bicycle-tire pump, a strong bottle of water being interposed, so that any air supplied has to bubble through the water; it is well also to rinse the inside of the globe with water, because otherwise it becomes misty and is soon difficult to see through. Things being thus prepared, burn a scrap of sulphur inside the vessel, which may be conveniently done by having a little cotton wick previously soaked in melted sulphur, and then, when cold and dry, lighted for a few seconds in the mouth of the globe; only a trace of burnt sulphur is wanted, otherwise it will itself make a smoke; then put the bung into the neck of the globe and slowly pump air into it (which, by bubbling through the water, becomes fairly damp), until the pressure has risen as much as is safe. Wait a short time, say a quarter of a minute or so, for the heat of compression to escape, and then remove the plug. It will indeed blow itself out when slightly loosened, and the compressed air will instantly expand, thereby chilling itself and depositing its vapor in the visible form of mist or fog—town fog in this case, because of the presence of the sulphur-combustion products—the thick, dense, yellow variety. There it will hover and remain for a long time, completely filling the globe as an opaque cloud, which is very visible; but to study its detail and behavior it may be illuminated by the beam of an electric arc, or in the daytime it may be well seen by looking through it at a window behind the globe. Then introduce a point—an insulated point—through the neck into the interior of the globe, and supply the electricity by momentary excitation of the coil. The instant the electricity is supplied the fog is seen to be in motion, black or dust-free spaces arise in it, the particles begin to coalesce and cling together, and in a very short time the whole of the fog has disappeared, being deposited upon the sides of the vessel as a dirty wet deposit, or, if dry smoke has been used, as a kind of black snow. With such a smoke as burnt magnesium, the effect of an imitation snow-storm in the air is very soon produced by the electricity, and the walls and floor become coated over with white.

ELECTRICITY AND MIST.

As to the *kind* of electricity which it is best to discharge into a fog, it is a familiar experience that negative electricity escapes from points rather more easily than positive does. Hence that is one advantage in using negative; but there is a further advantage. A fog or mist is itself usually more or less electrified, and the sign of the electricity with which it is charged is generally positive. Electroscopes at meteorological observatories indicate this general positive electrification of mist, and they further show that when the mist begins to drizzle and clear away, or turn into rain, the sign of the electrification is frequently reversed and becomes negative; in fact, negative electrification is generally associated with rain.

Now it is difficult to say which is cause and which is effect in such a case, but if two things are accustomed to go together, then the artificial production of one may bring about the other. Certainly the easiest way of dispersing a cloud or mist or fog is to bring it down as rain; and if it is artificially supplied with negative electricity, that is what is very likely to happen, for that is what certainly happens on a small scale in the laboratory. In the laboratory, however, it must be admitted that either positive or negative electricity will serve the purpose; though, on the whole, negative electricity does rather the better, perhaps because it escapes more easily; and large-scale experiments in open air, involving a considerable amount of capital expenditure, are still wanting. But there is every reason to suppose that the natural positive electrification of a fog will assist the discharge of negative electricity from points immersed in it, and that the electrification thus supplied will result in its condensation and dissipation.

The whole of the arrangement, if it is to be applied on a large scale with currents derived from engineering mechanism, interrupted automatically and transformed to high-tension intermittent currents at each post or discharging-station, depends on the efficiency of the electric valves employed.

These are of many kinds; any air-gap is liable to act to some extent in that direction, inasmuch as it can transmit electric pressures above a certain magnitude, and must obstruct those below that critical magnitude; hence if it is interposed in the path of an alternating current of which the opposite pulses are propelled by electromotive-forces of different intensity, half of such pulses may go, and the other half may be stopped. That is the case, for instance, in ordinary experience with the usual spark gap in the secondary of the common Ruhmkorff coil; it acts, in fact, as a

* Read before the Royal Institution of Great Britain.

rectifier or valve when it is of sufficient length to check the current at "make," and yet is short enough to yield to the force of the current at "break." If its terminals, instead of being similar, have different surfaces—as, for instance, if one is a point and the other a plate—then its rectifying or valvelike action can be exerted on pulses of opposite direction even if they are urged by forces of the same magnitude; and if the two terminals are put into a vacuous receiver instead of being left in common air, the ease with which they will transmit electricity either in one direction or the other depends upon the thoroughness of the vacuum; and in certain states of the vacuum the effect may be very marked, as has been known for some time.

Mr. Edison observed some years ago that if one of the terminals was hot and the other cold, the valve-tendency, or rectifying-action, was singularly perfect and effective at very low forces; for instance, if the incandescent loop of an ordinary Swan lamp be used as one terminal, and a piece of cold metal in the same bulb be used as the other, Sir William Preece found that such an arrangement could hardly convey a moderately propelled current in one direction, while in the other direction it could easily convey such a current even though driven with infinitesimal force; and an arrangement like this has been recently adopted by Prof. Fleming to make excessively feeble alternating currents record themselves on an ordinary sensitive galvanometer, and thus to get an instrument metrically responsive to the faint alternating impulses received at a distant station in wireless telegraphy.

These devices deal chiefly or wholly with impulses of low tension. For high-tension work the mercury-lamp invented by Mr. Cooper Hewitt, which excited so much interest a few years ago, when supplied with the proper appendages designed by him, acts in a surprisingly efficient manner.

It consists of a tube containing nothing but mercury vapor, with electrodes ingeniously arranged so that at a certain stage of exhaustion the current shall be transmitted with fair ease in one direction and barely able to go at all in the other, unless driven with much greater force; and these lamps are till lately the rectifying device or valve which in the fog experiments I have chiefly employed. They are, however, for some purposes not overportable; the strain on the glass is great, and they are rather liable to break; they are excellent for the purpose for which they were intended—as lamps—but as rough-and-ready valves for discriminating between opposite rushes of electricity on an extensive scale they leave much to be desired; so that I now employ a new and specially designed form of valve with special appliances for preventing excessive strain upon the glass.

OTHER USES.

Other uses than smoke deposition can be found for electric valves in connection with a high-tension intermittent supply; for instance, they can be used in any portable arrangement for the sending end of wireless telegraphy, as well as for metrical purposes at the receiving end; and they have been so applied by Dr. Muirhead in Kent and elsewhere. For, on our system of wireless telegraphy, there is an aerial Leyden jar to be charged—one capacity area elevated, and another conducting area near the ground, though not usually connected with it, and sparks have to be caused between these two, as in Hertz's old arrangement. Such a capacity is too great for a small coil to charge at each impulse of its secondary current; but if valves are inserted and a rapid break employed, the impulses of a number of sparks accumulate until the areas are filled to bursting, and then they overflow through the discharging knobs and give the required signal, the whole operation taking place in a fraction—though with a small portable coil and considerable distances to be reached, not a very small fraction—of a second.

Another use is for the production of X-rays, especially for visual purposes on a fluorescent screen; because by the reservoir and trap method of excitation an almost steady illumination can be maintained, thus giving a much brighter effect than can be produced by intermittent illumination, even though the property of the retina called "persistence of impression" does suffice to mask the really intermittent character of the light. For such purposes it is best to use a very large coil and a rapid break. I prefer to use either a revolving mercury break or a Caldwell; on the whole, I prefer Mr. Caldwell's modification of the Wehnelt or electrolytic break. It consists of a very small aperture or throttle introduced into the path of a 200-volt circuit, containing self-induction as well as the primary of the coil or coils, the said aperture or throttle being submerged under a conducting liquid, like dilute sulphuric acid, through which the primary current has to pass; and I make the apertures in a replaceable crockery hemisphere. The current transmitted through liquid in such a minute orifice is excessively intense; and the heat there developed, it must be supposed, almost instantaneously vaporizes the liquid in the aperture, and thereby suddenly stops the current; but the instant the current stops the steam collapses, the broken liquid is reunited, and the current again flows—to be immediately stopped as before. The rapidity with which this action goes on is astonishing—hundreds of times a second—and since there is no mechanism nor anything requiring attention, until the hole wears too large by reason of the violence of the shocks, there can hardly be any automatic break simpler in character than this; though it is quite likely that other still more efficient plans will be devised. Indeed, already the method just exhibited in London by Mr. Isenthal, employing the reversal of a "Grisson" electrolytic condenser through the primary of a coil, may possibly be a better one.

At any rate, by some means or other, the primary current is made violently intermittent; the secondary is then likewise an intermittent current of vastly increased force, though less in quantity; and in its path some valves are placed, as many as are needed. By the use of the valves a number of pulses are all stored in a Leyden jar or other suitable condenser able to stand excessive tension without overflowing, except in the direction and for the purpose desired. And thus along this overflow or discharge path the intermittence is superseded, and a continuous current of excessively high tension is maintained, as if it were coming from a battery of an enormous number of cells. Thus can be maintained a steady discharge from a series of points, with audible and persistent fizzy noise; thus also can an X-ray bulb of high exhaustion be kept steadily illuminated for the production of very penetrating rays. And if such a current be taken through a highly resisting conductor like a damp string, the string begins first to steam, then to glow, then to char and sparkle in places, then to catch fire and char throughout, then to break and interrupt the current, except in so far as it can jump the gap in a torrent of very noisy sparks.

CONTEMPORARY ELECTRICAL SCIENCE.*

LESAGE'S THEORY OF GRAVITATION.—G. H. Darwin employs rigid mathematical methods for investigating the consequences of Lesage's theory when certain assumptions are made with regard to the form, elasticity and surface condition of the elementary portions of matter and of the ultra-mundane corpuscles. He shows that if both are perfectly smooth and elastic there can be no force between them. But a moderate degree of inelasticity would suffice. A fundamental objection to the physical truth of Lesage's hypothesis lies in the fact that it demands a continual creation of energy at infinity to supply the gravific machinery. This objection recurs in an acute form on adopting the only supposition which gives a rigorous law of inverse squares—viz., that the corpuscles are completely inelastic and the roughness of the material spheres such as absolutely to annul the tangential velocity of a corpuscle on impact. In this case, the absorption of momentum on impact is total. This is the converse of the pressure of radiation. Two radiating and completely absorbing spheres at the same temperature repel one another rigorously in accordance with the law of inverse squares. If they are not at the same temperature, the cooler one is repelled more. If a body has a hot end and a cold end, it moves in space, the cold end leading.—G. H. Darwin, Proceedings Royal Society, No. A, 511, August 4, 1905.

DISTRIBUTION OF ENERGY IN SPECTRUM.—The direct determination of the distribution of energy in the visible spectrum of incandescent bodies is rendered difficult by the lack of an instrument sufficiently sensitive to indicate the energy in the more refrangible portion. With an exceedingly sensitive radiometer, the visible spectrum of an acetylene flame may be explored down to about 450$\mu\mu$. Such measurements have already been carried out. E. L. Nichols shows that on comparing the values obtained with those of a Hefner lamp as deduced by Angström from the compensated pyrheliometer, and on comparing the same spectra by means of the spectro-photometer, consistent results are obtained, which greatly increase the confidence felt in both methods. The author has, therefore, made a number of spectrophotometric comparisons of various sources of light with the Hefner lamp, and determined the relation between the temperature and the luminous intensity. He finds if a number of such sources have the same photometric intensity, the ergs per unit of illumination may yet be very different, ranging from 29 ergs for an untreated carbon rod at 1,273 deg. to 9.14 for the same at 1,673 deg., and going down to 4.39 ergs in case of a Welsbach burner at some 2,400 deg.—E. L. Nichols, Physical Review, September, 1905.

RESIDUAL E. M. F. OF THE ARC.—G. G. Becknell has studied the E. M. F. between the carbons of a direct current arc immediately after its interruption, and found that it can only be explained on an ionic or convection hypothesis. A plate of either copper or mica—that is a plate of material either conducting or non-conducting—when interposed between the electrodes without touching either of them, was sufficient to arrest the residual current entirely; but upon the removal of the plate the current was immediately re-established. A short copper wire joining the positive and negative electrodes was sufficient to stop entirely the residual current through the galvanometer, showing that the effect cannot be traced to a thermo-electric source existing outside the arc, for in this event the current would have been much increased by thus cutting out the resistance of the arc gap. The author concludes that the residual current is due neither to a thermo-electric effect in the arc nor to one external to it. As a further test, a gentle air-blast was applied to the region between the carbons at the instant when the galvanometer was thrown into the circuit. This, again, had the effect of removing nearly all traces of the residual current as long as the air current was continued, unless the poles were placed as nearly together as 1 millimeter, and even then the effect was reduced to one-tenth. The failure at this point to completely destroy the effect was probably due to the partial inaccessibility of this small region to the current of air. It was found, also, that when the air-blast was discontinued the residual current was set up again, provided the blast had not been applied for a time longer than four or five seconds. The author bases his attempt at an explanation upon the fact that carbon emits electrons at high temperatures. The positive terminal being about 1,000 deg. hotter than the negative, the former emits many more electrons than the latter. While the current passes, the surplus electrons are crowded at the positive carbon on account of the electrostatic field. When the latter is abolished, they produce a convection current opposed to the original current, and lasting for several seconds, until the temperatures of both terminals have become equal. This point is reached more quickly in graphite, which, therefore, shows the phenomenon in a much less marked manner.—G. G. Becknell, Physical Review, September, 1905.

CAPACITY AND TEMPERATURE.—E. M. Terry finds that a condenser has a temperature coefficient depending in value upon its construction, that it is negative, and of sufficient magnitude to require consideration when used in measurements of high precision. The determinations of capacity were made by means of the alternate-current galvanometer as used by Stroud and Oates. To determine the temperature coefficient a bridge method was used. Both capacities were placed in tin boxes immersed in large water baths. One was kept at a constant temperature, while the other was varied between 17 deg. C. and 33 deg. C. The water was kept constantly stirred by two turbines driven by a water motor, while the temperature could be held at any point by means of a thermostat to 0.1 deg. C. for any desired length of time. Owing to the large thermal capacity of the condenser it usually took about 48 hours for it to come to a uniform temperature throughout. The temperature coefficient was found to be — 0.00011 mfd. per degree in case of a condenser of 0.05 mfd., and — 0.00033 in case of another capacity 0.2.—E. M. Terry, Physical Review, September, 1905.

TERRESTRIAL MAGNETISM AND THE ECLIPSE.—T. Moureaux has traced a perceptible influence of the solar eclipse of August 30 upon the magnetic elements at Poissy, where a temporary magnetic observatory was erected, and observations made from August 30 to September 10. The magnetograph was installed in an old limestone quarry, 60 feet below the level of the soil, where the temperature was constant, and equal to 9.5 deg. There were frequent magnetic perturbations, which must have interfered with the eclipse observations. The declination underwent several oscillations during the eclipse, the extreme amplitude being 4 min. The most pronounced minimum was at 0 h. 26 m., and the maximum at 1 h. 54 m. The horizontal force also passed through several oscillations, with an absolute minimum at 0 h. 6 m., shortly after the beginning of the eclipse, and a maximum at 2 h. 27 m., a few minutes before the end. The total difference was 0.00030 C.G.S. units. These variations are decidedly greater than the regular diurnal variation. Ordinarily, in August, the declination does not vary by more than 1 min., or the horizontal force by more than 0.00008. The temperature showed a lowering of 1.5 deg. in the shade on the surface, and this was the same at Parc St. Maur and at Val-Joyeux.—T. Moureaux, Comptes Rendus, September 4, 1905.

* Compiled by E. E. Fournier d'Albe in the Electrician.

PLANT BREEDING.

By H. H. GROFF.

WHERE the worker for practical and economic results has not been subjected to a complete and early schooling on the theoretical aspect of plant breeding, many valuable points of a corroborative character, as well as facts of experience that dispose of error in previous deduction, are lost to the records of scientific discovery and research.

The force of the foregoing was most apparent to Prof. Bailey, of Cornell University, when, after a few disjointed remarks by me, at the International Plant Breeders' Conference, held at New York in October, 1902, he called attention to the importance of recording such experiences in the interest of all plant breeders, and I had the honor of being associated with Prof. Bailey and Prof. Hays (the latter now Assistant Secretary of Agriculture at Washington) as to the best means of securing such records from private investigators.

The fact that important scientific discoveries are made by men who have had little or no early theoretical training, is sufficient encouragement to workers of critical and practical temperament to pursue their investigations on independent lines of thought, with the assurance of some measure of success, and while no theoretical training on general lines is to be decried, there are occasions when its absence leaves the mind more free for practical development on special lines, with the possibility of securing phenomenal and valuable results.

The elasticity of the human mind has its limitations, and these are often hastened to their conclusion by the physical condition of the individual, be those conditions the product of hereditarily transmitted peculiarities or personal habits, or both.

One of the first points to be fixed on the mind of the independent and well-balanced investigator is the absolutely limitless character of the field chosen for specialization, and if he is wise he will at the earliest moment compass the possible and visible field in his operations, in order that he may secure from all parts of the world as foundation laboratory stock, every available chemical constituent and vital force that has survived the disintegration of adverse local and climatic conditions.

If this be not done at the earlier stage of operation, many valuable features inherited from the ages of the past will not be available for future use when the operator, moving on parallel lines with each wild species as a parent with a special object in view, desires to unlock these treasuries by a judicious cross between the types so produced.

It was fortunate for me that, at the earlier stage of my operations, I secured every available classified wild species of my specialty, as well as many of later discovery by botanical explorers. I mention this to add force to the foregoing remarks, for the reason that as the operator draws away from and discards these wild species, the field will broaden yearly, with its horizon limited only by his activity, and that it is lost time to go back to any point from which the most rapid removal is imperative. This conclusion will soon force recognition from his mind, for he will not advance far into the field of practical and successful activity before he will be compelled to specialize his specialty and limit his operations to those lines which his intelligence and experience will now tell him should be productive of the best results.

At this stage of his experience he will find that while he may have begun his investigations as uneducated by the academic standard, he is now learned in all that his mental capacity, powers of observation, and material for operation have made possible, assuming, of course, that no unreasonable limitations have been placed upon his activity in the field. I am speaking from an experience of fifteen years of unbroken activity, with all available material, resulting in over half a million new productions in one plant only, the gladiolus, a semi-tropical, half-hardy corm, developed under adverse climatic conditions by cross-breeding and hybridization.

Without reference to the practical aspect of hybridization for the purpose of producing valuable economic types, I will note a few features of interest from the purely scientific point of view.

It is apparent that in the composite hybrid the vital forces move on parallel lines. This has been evidenced by the independent opening of the flowers on each side of the spike. Normally these open in order of arrangement, but at times those on one side open in advance of those on the other. Another example of the above was the product of a cross containing infusions of white and red blood—the two colors separated—giving white flowers on one side of the spike and red ones on the other.

The influence of multiplication of the petaline element in breeding is apparent in the production of twin corms from a single seed of such types. This fact proved most interesting to Prof. Bateson, of England, at the conference referred to.

The relaxation of the bonds of heredity by selection in breeding and the appearance of vital forces from a period predating the effect of the selective action of natural conditions that produced the species, is also apparent in the appearance of flowers resembling those of the iris Kæmpferii, a plant of the same natural order. The chief peculiarity of these is the form of the flower and its presentation on the spike.

One of the most remarkable variations, however, is one with the above tendency and in addition, a vine-like disposition to twist and twine, and if my conclusion is correct, this peculiar vital force must come from the ages that caused the appearance of the earlier natural orders entering into the original composition of the species. This variety is totally different from the species that produces a uniform crooked spike, a peculiarity that we expect to be transmitted by such species, and an objectionable one. This type is being multiplied and the matured plants invariably showed the peculiarity referred to during the past season (1905).

A point that has strongly impressed me from the practical aspect is the gain in increased adaptability of the plant to changed conditions by means of development in soils of diverse character. On my farm there are four—sandy, sandy loam, clay loam, and vegetable—deposits. My experience enables me to say, that where a variety is developed exclusively on one kind of soil, change to another is more or less a shock. At times, however, the change is beneficial, but more frequently it is the reverse, and my reports on performance from various parts of the world have so confirmed my opinion that I prefer to develop on all available soils in bringing to maturity.

Examples of total and partial sterility are quite frequent in my specialty, but these are invariably accompanied by some compensating quality in point of multiplication by offsets or division. In some cases there are types capable of large cormel production, but which lack vitality in the parent corm, while on the other hand we have those of limited reproduction by such offsets—but which multiply more freely by division of the mature corm, with greater vitality and durability, when so matured.

The appearance of domestic types having the characteristics of wild species was reported by me some years ago through the New York horticultural press. The importance of this was not noted at the time by scientists, but the later reports of Prof. de Vries, of Holland, have since confirmed my contention. Prof. de Vries experimented to prove the correctness of his theory, while I by breeding discovered the fact.

The importance of using domestic specific types as sires on selected varieties prepared for seed bearing, on the line of practice by animal breeders, is too lengthy a subject to be added to this article. I have referred to it on two occasions, before the American Breeders' Association. It is the most effective system to be practised in breeding for fixed results of economic value.

While examples supporting the newer theory of mutation are not numerous in my experience, so far as marked variation of type is concerned, they are sufficiently so to give strength to this reasonable contention. I am multiplying some distinct types that show material variation, with satisfactory promise of their peculiarities becoming fixed. Each year, however, sees the rise of new and distinct types, which open newer and broader fields of operation and each showing a marked advance on those preceding.

BARREL CONSTRUCTION OF TUNNEL THROUGH THE CONCRETE WALL AND FRAME FALSEWORK FOR CENTRAL WALL.

CONCRETE RETAINING-WALL AND TUNNEL.

By HERBERT I. BENNETT.

THE interest attaching to the tunnel through the Santa Cruz Mountains—which is herewith illustrated—is of an engineering nature, inasmuch as it is approached at one end through a concrete retaining-wall, or dam, that has stood for over eleven years without evincing the least sign of cracks, or other failure.

THE TUNNEL-PIERCED CONCRETE RETAINING-WALL AND SPILLWAY.

The tunnel forms the summit of the narrow-gage portion of the Coast Division between Wright and Laurel stations, at a point about 62 miles south of San Francisco. It is 1.16 miles in length. The north portal at the Wright station end is a 200-foot concrete structure, entered through a concrete retaining-wall, the wall being built to hold back the sliding mountain, and the concrete tunnel extending through the side to the solid rock. During the winter of 1892-3, the Santa Cruz Mountains were visited by unusually heavy rains, and as a result of the storms a landslide carried away about 200 feet of the north end of the Wright tunnel, the damage having been so complete that it was necessary to suspend traffic over the railroad in question for several months, or until the tunnel could be repaired. At this point, a tributary to Los Gatos Creek, flowing due east, is joined by a side creek flowing north, and both creeks are almost dry during the summer months; but in the winter the rains convert them into raging mountain torrents. Prior to the great landslide, the railroad track crossed the side creek a few feet away from its junction with the north creek, and near the portal of the tunnel. The landslide was caused by the two creeks cutting through the clay bed to the rock below, which action made the whole hillside, for about 300 feet back, slide forward toward Wright station, filling the narrow throat between the points of rock at the portal of the tunnel, and completely crushing in the first 200 feet of tunnel, which was carried down with the slide. The whole mass appeared to be afloat on a film of water between the clay and bedrock, and numerous attempts to reconstruct the end of the tunnel and portal with heavy timber and iron proved failures, while there was every promise of further trouble later on, should ordinary repairs have been resorted to. After a lengthy discussion, the engineers, John G. Isaacs, engineer of bridges, and W. G. Curtis, engineer of maintenance of way, decided upon the novel plan of re-establishing and maintaining the toe of the slide by raising the beds of the two creeks above the tunnel, instead of having them under the railroad track. It was a clever thought, and that is one of the reasons why the Wright tunnel has attracted attention among railroad engineers. The river beds were raised through the construction of a concrete masonry retaining-wall across the mouth of the tunnel, the wall running between the rock points at the portal, and from the wall, or dam, the concrete tunnel was carried through to bedrock, a distance of 200 feet, connecting continuously with the tunnel through the mountain. The toe of the slide was re-established by filling the beds of both creeks, and by carrying the side creek from the south, behind the wall over the top of the tunnel, and causing it to join Los Gatos Creek at the spillway. This spillway carries the combined streams that pour a heavy volume of water into Los Gatos Creek during the rainy season. The retaining-wall is about 28 feet in height from the rail base, 14 feet thick at the bottom and 2 feet thick at the top, and the tunnel which pieces it is of oval shape and of varying thickness.

Owing to the tunnel cutting through the slide, it had to be arranged so as to transmit the thrust of the slide from south to north; therefore the sides of the barrel were carried down to bedrock, and a key-piece put in under the track, and the earth was thoroughly tamped on both sides of the barrel. The barrel was, in effect, made part of the slide, and the slide provided with a toe, and the top of the tunnel was loaded with earth from 15 feet deep, at a point 42 feet back from the retaining-wall, to 25 feet deep at its further end. The entire wall, including the dam, contains approximately 108,000 cubic feet of concrete, and the masonry is a concrete monolith. The concrete was mixed in the following proportion by volume: One part Portland cement, two parts sand, three parts gravel, and four parts rock broken sufficiently small to enable it

to pass through a two-inch ring. The entire portion below the base of rail, with the exception of the key-piece under the track, contains large pieces of rock that vary from one-quarter to one cubic yard. Above the rail base the same concrete mixture was employed, but minus the large stones. The rock used in the work is very strong—a heavy blue trap, quarried at the side of the railroad near Campbell station, about 12 miles east of Wright. It required about one month to place the concrete in position. The tunnel through the wall was built with the aid of segments and lagging made of two-inch planking, and falsework of 12 x 12-inch timber. The falsework remained in position through the winter of 1893-4 and was taken out during the following summer, the wall having become thoroughly set by that time.

The line on which this work was done operates between San Francisco and Santa Cruz, a distance of 80 miles. The solidity of this retaining-wall is assured for all time, as it is practically a solid block of stone without a single crack or flaw after having stood for over eleven years. The writer is indebted to Mr. John D. Isaacs, engineer of bridges of the Southern Pacific Company, for the data and photographs covering this interesting railroad subject.

RECENT PROGRESS IN METALLURGY.*

By A. E. Outerbridge, Jr., Professor of Metallurgy, Franklin Institute.

The days in which steel was practically regarded as an iron containing a certain proportion of carbon have gone by. We have learned that the other elements, always present in steel, exert a decided influence on all the properties of the iron; but we are still far from understanding the real nature of the purest steel.

While the inexperienced investigator may too readily imagine that he has struck at the root of the problem, Prof. Arnold declared in a discourse delivered before the British Association, August 31, that he had to confess, after research extending over a quarter of a century, that the more he learned about steel the less he knew of its ultimate nature. Homogeneity is the great aim which most metallurgists have in view, but Prof. Arnold thinks that safety is to be found in want of symmetry, not in the visible structure, however, such as the microscope reveals, but in the molecular grouping, about which the microscope does not tell us anything. He regards steel as an igneous rock, more or less crystalline. There is, in his opinion, a certain analogy between granite and steel. The granite is built up of quartz, feldspar, and mica; the steel of the constituents of ferrite, pearlite, and cementite. In an unsaturated steel containing about 0.5 per cent of carbon, the microscope allows us to distinguish patches of iron; the saturated steel with 0.9 per cent of carbon, looks more homogeneously speckled with pearlite; in the supersaturated steel the iron carbide or cementite is seen to form cell-walls, and the cementation proceeds from the outside. Reference is made to several mysterious failures of steel and to micrographic and chemical tests, as well as physical tests of pieces of the metal, none of which offered satisfactory solution of the failures.

The explanation that failures often result from fatigue of the metal is characterized as only "a convenient term coined to mask our ignorance."

The tentative conclusion at which Prof. Arnold has arrived in explanation of certain strange fractures of engine, boiler, and structural steel is, that after the gross crystallization, discernible by the highest microscopical powers, has been completed on cooling, there set in, from a series of centers, molecular movements tending to the production of perfect mineral cleavage. This cleavage cannot easily be detected by the microscope, as steel is absolutely opaque to transmitted light. To avoid the development of cleavage planes the molecular structure of the steel should be asymmetrical. That crystallization proceeds from a series of centers can be demonstrated in many substances, and the decomposition and disintegration will start from the same centers.

I would say, in passing, that while steel is, of course, opaque to transmitted light of ordinary kind, it is by no means opaque to the passage of X-rays or of radiations from radium.

Reference was made by Prof. Arnold to an accident caused by failure of an end-plate of an old boiler, which had cracked completely across, in which the tests subsequently made of the metal could not account for the accident.

It has always seemed to me that there is one inherent defect in the prevailing practice of testing such metal, by cutting coupons from the plates after failure, in that they are tested at the ordinary temperature of the atmosphere, but the failure occurs usually while the metal is hot. It is, therefore, interesting to note that some elaborate tests of the "Elastic Properties of Steel at High Temperatures" have been recorded in a paper read before the Royal Society by Prof. Bertram Hopkinson and F. Rogers, of the University of Cambridge, printed in Engineering Sept. 8, 1905. In these experiments the elastic properties of steel and iron have been investigated at temperatures ranging up to 800 deg. C. (1,472 deg. F.) It was found that "as the temperature rises the stress-strain relations undergo a remarkable change, which may be best expressed by saying that what is variously called the 'time-effect,' or *elastische nachwirkung*, or 'creeping' increases greatly with the temperature. Steel at high temperatures behaves like India rubber or glass; if it is stressed for a time, and the stress removed, it does not at once recover; but after the immediate elastic recovery there is a slow contraction perceptible for many minutes. Such creeping can be detected at ordinary temperature, but at red heat attains a different order of magnitude, becoming (in its total amount) a substantial fraction of the whole deformation."

Test pieces 4 inches long and 0.2 inch in diameter between shoulders, having enlarged threaded ends screwed into two steel bars 10 inches long, 1⅛ inches diameter, were used, the whole being inclosed in an electric resistance furnace wound with three coils of nickel wire. The currents in these coils could be separately controlled, and in this way the temperature along the test piece could be maintained very approximately uniform. The temperatures were measured with three thermo-couples, placed one at each end and one at the middle of the test piece. Changes in length could be measured correctly to 1/50000 inch by means of an extensometer. The furnace was supported separately, and the test-bar, with the attached extensometer, was hung free within it. Tension up to 1½ tons per square inch could be very rapidly applied or removed; the interior of the furnace was closed from the atmosphere by means of mercury locks, and the test piece was kept surrounded by an atmosphere of nitrogen, so as to avoid oxidation. Diagrams accompanying the paper show the results of a series of tests carried out on a steel bar at 750 deg. C. This bar was at no time heated much beyond that temperature. It was loaded with 85 pounds (about 1¼ tons per square inch) for one minute, then unloaded for two minutes, and so on, and the curve shows the resulting changes in length in terms of the time. Even at this low stress the metal flows fairly rapidly, and the over-straining has a considerable hardening effect, as is shown by the diminishing amount of permanent set produced by successive loadings. This hardening disappeared with rest, that is, if the bar were left unstressed at 750 deg. C. for a couple of hours after having been hardened by successive loadings, it was restored to its original soft state.

In respect to all the features mentioned the properties of the material differ only quantitatively from those of a cold bar but for one remarkable difference. This difference lies in the behavior of the bar after the removal of the load. The cold bar does not contract appreciably; there is the instantaneous elastic contraction, then it stops. The hot bar, on the other hand, goes on shortening for two minutes or more after the load is off, and the total shortening amounts to about one-third of the instantaneous contraction, or one-quarter of the total contraction. This phenomenon is analogous to residual change in glass and other dielectrics, the stress corresponding to the electric force, and the strain to the electric displacement. The magnitude of this effect in steel may best be gaged by comparing it with other cases of the same kind, i. e., with the slow recovery of the glass fiber after twisting; if such a fiber be twisted through a considerable angle for several hours, it will recover all but one-fiftieth of the twist within two or three seconds of the removal of the stress. The remaining slow "creep," amounting to one-fiftieth of the whole deformation, corresponds to the slow return of the steel.

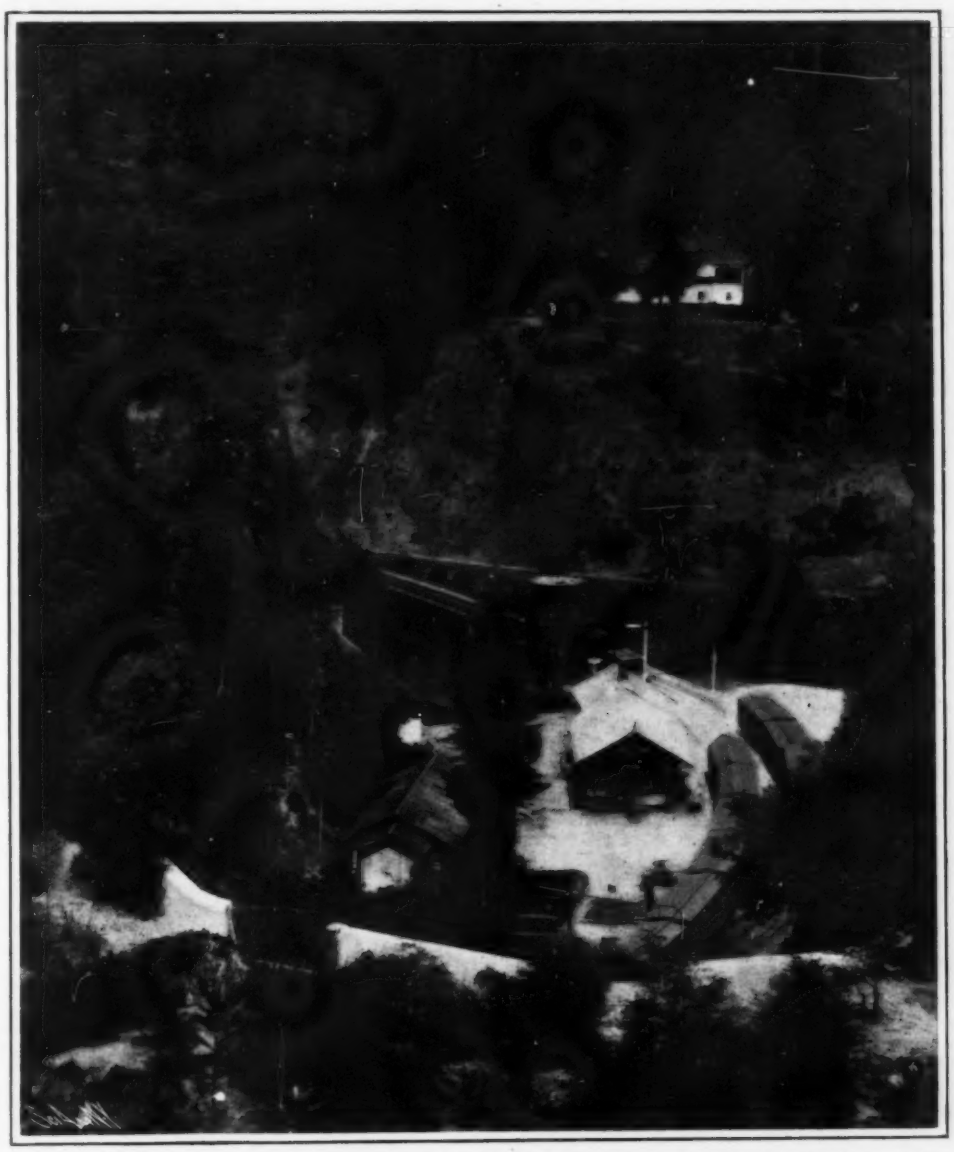
In India rubber, under certain circumstances, 10 per cent of the stress and the strain disappears in time after the removal of the stress. But in steel at 600 deg. C. the proportion is about 15 per cent.

One effect of such a time-lag will be to cause dissipation of energy if the material be subjected to alternating stress, for it will lead to a difference of phase between the stress and the strain; and the amount of the dissipation will depend upon the period of the oscillations.

The authors state that another effect of the "creeping" is to make the determination of Young's modulus a matter of some uncertainty, but it would take too much time to consider this phase of the subject here. For further particulars I refer to the original article, which I found exceedingly interesting.

A few months before the publication of these tests of the elastic properties of steel at high temperatures, Mr. R. A. Hadfield, president of the Iron and Steel Institute, read before that association his remarkable paper on the effect upon the mechanical and other properties of iron and its alloys produced by liquid air temperatures. This is a highly interesting and valuable contribution, giving the results of numerous costly and carefully-conducted original investigations. The author stated that as many iron alloys had shown anomalous results in their physical behavior at ordinary temperatures, it became desirable to ascertain the exact effect of very low temperatures upon such bodies, and accordingly he carried out a series of tests on standard iron and on iron alloyed with other elements. In the course of the inquiry no less than five hundred specimens were examined. The bars experimented on were finished to 0.18 inch in diameter and

* Journal of Franklin Institute.



VIEW FROM TOP OF CONCRETE TUNNEL PORTAL LOOKING NORTH TOWARD WRIGHT STATION, AND TRESTLE OVER LOS GATOS CREEK INTO WHICH THE TWO SIDE CREEKS DISCHARGE THROUGH THE SPILLWAY IN THE TUNNEL WALL.

CONCRETE RETAINING-WALL AND TUNNEL.

were 2 inches long in the parallel part and 3.20 inches over all. The size of the specimens, therefore, did not vary greatly from that of the tests made by Prof. Hopkinson on the elastic properties of steel at high temperatures. The two investigations had no relation with each other, but it seems appropriate that they should follow one another as a corollary.

The first specimen examined by Mr. Hadfield was of Swedish charcoal iron, approaching pure iron in its composition. The analysis gave Fe 99.82, C 0.045 per cent, Si 0.07 per cent, S 0.005 per cent, P 0.004 per cent, Mn trace.

This iron, after careful annealing, gave twenty tons per square inch tenacity, and 20 per cent elongation at normal temperature; after cooling in liquid air the tenacity rose to thirty-eight tons, with substantially no elongation. Another specimen, after being quenched at 950 deg. C. and again at 600 deg. C. in water, showed similar results in liquid air. Two other specimens in the unannealed condition, and one after special heat treatment, showed similar properties. Specimens immersed in liquid air, and allowed to return to the normal temperature before testing, had almost exactly the same tenacity and elongation as before cooling, thus showing that the brittleness was entirely a function of temperature. In addition to tests made on specimens of steel with various amounts of carbon, alloys of iron and chromium, tungsten, silicon, aluminium, and copper were tested. Mr. Hadfield's conclusions are as follows:

"Practically at this low temperature (—182 deg. C.) pure iron has its tenacity more than doubled; its well-known ductility falls very low; its magnetic properties remain almost the same as at higher temperatures.

"This represents the general behavior of all alloys excepting those containing nickel, which are less affected, as regards loss of ductility, while an iron alloy containing 5 per cent of manganese and 25 per cent of nickel has its extraordinary ductility, about 60 per cent, still further increased, and the tenacity also largely increased. Manganese steel has its ductility lowered; but its non-magnetic properties remain apparently unaffected. The whole of the results combine to offer a most interesting field for observation of the physical properties of iron, both at ordinary and at liquid air temperatures."

Related more or less closely to these investigations we may properly refer briefly to the great advance that has been made in knowledge of the influence of heat treatment on the physical properties of steel, and of the practical use that is being made of these observations. We now know that the proper heat treatment of steel rails before, during and after rolling is of vital importance in the production of good rails. Good material may be spoiled by bad treatment at a critical moment of the rolling. The microscope has found a field of great usefulness in enabling the chemist to determine whether a failure is due to faulty heat treatment or to other causes.

Passing now to the consideration of recent advances of a practical nature in metallurgy, it seems to me that one of the most interesting developments within the year has been shown in the paper of Mr. James A. Gayley on the application of dry air in blast furnace practice. So much has been written upon this subject since the original paper appeared in print that it would be superfluous for me to do more than allude to it here. While it was by no means a new observation that the amount of moisture in the atmosphere exerted a decided influence on the product of blast furnaces, no one had apparently anticipated the gain in economy which Mr. Gayley showed by his method of freeing the air of its moisture before passing into the furnace. So remarkable are these results that various theories have been advanced to account for them of more or less abstruse nature. It remains still to be seen whether the method will be found sufficiently advantageous and economical to warrant its universal adoption. In these days of scientific progress in the production of pig-iron in enormous furnaces, new methods meet with prompt encouragement from furnace proprietors and it is to be hoped that Mr. Gayley's ingenious plan will prove thoroughly successful.*

MAGNETIC NON-IRON ALLOYS.

Prof. J. H. Fleming and R. A. Hadfield in a recent Royal Society paper, give the latest results of their work of investigation of the magnetic qualities of some alloys not containing iron. The alloy experimented with was composed of manganese, 22.42 per cent; copper, 60.49 per cent; aluminium, 11.65 per cent; carbon, 1.5 per cent; silicon, 0.37 per cent; iron, 0.21 per cent. About 2 or 3 per cent of slag was intermingled, mostly consisting of manganese and silicon oxides, with slight traces of metals other than the above mentioned. The conclusions of the paper are as follows:

The above alloy exhibits magnetic properties which are identical with those of a feebly ferro-magnetic material.

The magnetization curve is of the same general form as that of a ferro-magnetic metal, such as cast-iron, and indicates that with a sufficient force a state of magnetic saturation would most probably be attained.

The alloy exhibits the phenomenon of magnetic hysteresis. It requires work to reverse the magnetization of the material and to carry it through a magnetic cycle.

The material has a maximum permeability of 28 to 30, which is not greatly inferior to that of the values reached for cobalt or a low grade of cast-iron for small magnetic forces, and occupies a position intermediate between the permeability of the ferro-magnetic and the merely paramagnetic bodies, such as liquid oxygen and ferric chloride.

The material exhibits, therefore, the phenomenon of magnetic retentivity and coercivity. It is not merely magnetic, but can be permanently magnetized.

A further conclusion is that the magnetic properties of this alloy must be based on a certain similarity of molecular structure with the familiar ferro-magnetic metals. The hypothesis which best fits the facts of ferro-magnetism is that materials such as iron, nickel, and cobalt are composed of molecular groups, which are permanently magnetic, and that the process of producing or changing the evident magnetization of a mass of these metals consists in arranging or disturbing the positions of these molecular magnets. Since, then, we have in this alloy an instance of fairly strong ferro-magnetism produced by an admixture of metals possessing in themselves separately no such property, it follows that ferro-magnetism *per se* is not a property of the chemical atom, but of certain molecular groupings. The importance of this fact cannot be easily overstated. It shows us that in spite of the fact that ferro-magnetism has been hitherto regarded as the peculiar characteristic of certain chemical elements—iron, nickel, and cobalt—it may, in fact, depend essentially on molecular grouping composed of a comparatively large number of molecules, and, hence, it may be possible to construct alloys which are as magnetic, or even more magnetic, than iron itself.

Commenting on the paper, the London Electrician says that the discovery of the secret of the molecular grouping referred to would be of immense importance, as it will lay bare the whole mystery of magnetism, and might make possible the manufacture of a material even more magnetic than iron itself.*

BY-PRODUCTS.

The utilization of so-called "waste products" is daily becoming more and more important, and in some industries the recovery of by-products, which were formerly thrown away, proves actually more profitable to-day than did the original operation in former times. Among the inventions aiming to recover waste products most deserving of notice here is "Clamer's Method of Eliminating Metals from Mixtures of Metals." This process was investigated by the Committee of Science and Arts and the Elliott Cresson medal was awarded to Mr. G. H. Clamer for his invention, which has been patented and pushed into successful operation on a large scale in this city and elsewhere.

The report of the sub-committee states that the invention is a new method of utilizing brass scrap, and producing therefrom a merchantable bronze, or a material which can be used in the manufacture of merchantable bronze. If it is attempted to remelt scrap brass for use again the iron which unavoidably contaminates it, together with the lead and tin of the solder and oxide of zinc produced during the melting, make a remelted metal which is practically worthless. The Clamer process eliminates the oxidizable mixtures in an ingenious way by so regulating the ingredients of a charge of scrap and waste products for the furnace, based upon analysis of the scrap, that there shall be sufficient quantities of oxides of copper, lead, or tin to oxidize a certain quantity of zinc and iron. Not only are the impurities removed by these reactions, but the purifying materials on performing their function, and by reason of their reaction, are themselves reduced to the metallic state and contribute copper, lead, and tin to the bath. For every 65 parts of zinc or 56 parts of iron oxidized, there would be furnished 127 parts of copper or 207 parts of lead, or 118 parts of tin, or aliquot proportions of these, according to the proportions of oxides of copper, lead, or tin used. This fact is economically of great importance, because the oxides of copper, lead, and tin are found commercially in large quantities as waste products, called copper scale, and lead and tin dross, or skimmings, and are purchasable at a comparatively low price. By utilizing these waste products as active agents to eliminate impurities from another waste product, the deleterious materials (zinc, iron, oxygen) are all eliminated by mutual reaction, and only the useful combination, copper, tin, and lead, remains.

The practical operations are conducted on the hearth of a reverberatory furnace, lined with magnesite brick, and are simply and easily managed.

FERRO-SILICON IN THE FOUNDRY.

Among the comparatively new metallurgical products for which I think an increased use will be found, is an exceedingly rich ferro-silicon alloy, containing from 50 to 80 per cent of silicon.

Ferro-silicon containing from 12 to 20 per cent of silicon has been a commercial product for a long time, but the new very rich silicon alloy possesses distinctively valuable properties which I have discovered in the course of some extended investigations not heretofore published.

One of the difficult problems of foundry practice where miscellaneous castings are made is to economically obtain from one melting in a cupola different grades of iron suitable for different classes of castings requiring perhaps very different qualities of metal. Thus, the articles may range from castings of many tons weight, usually of thick section, requiring strong iron of close grained texture, often having high chilling properties, to small objects of a pound or so in weight, frequently of thin sections, which require to be machined, and therefore must be of softer metal having little or no tendency to chill.

As silicon is practically the *governor* that determines the degree of hardness of cast-iron, the value of a simple process that will enable the intelligent founder to control the proportion of silicon in any individual ladle of molten iron drawn from a cupola is apparent, especially in foundries where miscellaneous castings, ranging in size from small pulleys weighing a few pounds, with rims one-quarter inch thick, up to anvil blocks, bed plates for various machines, hydraulic cylinders and the like, sometimes weighing many tons and of varying thickness, up to twelve inches or more, as is the daily practice in the foundry with which I have been connected for many years. The silicon in such castings ranges usually from 2½ per cent to less than 1 per cent, and the customary method of operation is to group all the small work so that it will be cast at the beginning of the heat, followed by a medium grade of iron suitable for miscellaneous castings of medium weight and thickness, this again followed by large and heavy work requiring strong iron of close-grained texture, low in silicon, and having high chilling properties.

By arranging the work so as to have a certain number of castings to serve as "buffers," i. e., to take iron that is intermediate between the different grades charged in the furnace, this method has proved very satisfactory, and now it can, I think, be supplemented by *altering at will the silicon in any individual ladle*, to a nicety that is truly surprising.

In this way it is possible and practicable to use a lower grade of iron in the general mixture than could otherwise be done. At present the operation is confined to treating ladles of iron for the lightest class of work, requiring the softest grade of iron, so as to permit of machining at high rates of speed; but, when the price of ferro-silicon, containing 50 per cent and upward of silicon, shall fall, as I have little doubt it will, to a more reasonable figure, the use of it in the way I have here indicated will become general. I am led to make this assertion from experience based on my original investigations with ferro-manganese (80 per cent manganese) in car-wheel iron in the year 1886. The cost of ferro-manganese was then more per ton than the present price of ferro-silicon (50 per cent silicon). To-day it is less than half that price, and the use of ferro-manganese for certain purposes, especially in chilled cast-iron car wheels, in the way I described in my lecture on "Cast Iron," printed in the Journal of the Franklin Institute, March, 1888, and in practically the same proportions, has long since become well established. It has been stated in print by a recent writer that when the Pennsylvania Railroad authorities adopted the "thermal test" for car wheels, the wheels of nearly all the makers failed to stand this test, until a small quantity of ferro-manganese was added in the ladle just before pouring. This gave the metal additional elasticity that enabled the wheel to resist the severe strains caused by heating the rim suddenly in the thermal test.

As the result of a large number of experiments made with test bars of foundry iron treated with small quantities of ferro-silicon (50 per cent Si), say one-quarter to one per cent, I have found an average gain in strength of about 15 per cent, and a somewhat larger average gain in ductility, or bending quality, accompanied by a marked increase in softness of the metal.

I find that the addition of even so little as one pound of this alloy, in a powdered form, in a ladle containing 200 pounds of foundry iron produces a remarkable effect, not only as a softener, but what is more surprising and equally valuable, it is invariably accompanied by an increase in strength and resilience, or ductility, of the metal, although we have added actually a little less than 0.25 per cent of silicon to the iron. By adding four times this amount of the alloy to a very hard iron mixture of iron in a ladle which ran quite white when cast in thin sections, and was, therefore, entirely unsuitable for small castings requiring to be machined, I have found that I can produce a soft gray metal of good strength and ductility with low shrinkage, suitable for casting pulleys and other light work.

I am, of course, aware that it is not new to use brands of silvery iron, known as "softeners," containing five, ten, or perhaps even fifteen per cent of silicon, in the manufacture of iron castings, but so far as my experience goes in commercial practice, covering thirty years, the addition has been made in the cupola itself, which results in either what may be considered as a fixed product, or, if varied during the heat, in a product which is indeterminate, so as not to be predictable at a given moment of tapping.

I believe, therefore, that it is a new discovery to note the immediate diffusibility of the high-grade ferro-silicon when added to a relatively small quantity of melted cupola iron which has been withdrawn from the source of heat supply, and its capacity, when thus diffused, to produce definitely controllable results in the physical characteristics which are essential in different grades of castings.

The cost of the small addition of high-grade ferro-silicon in the ladle, even at the present price of the powdered alloy (about four cents per pound), is trifling, and is far more than counterbalanced by the fact that lower grades of pig iron may be used in the furnace, besides the practical value of being thus able to absolutely control the product and to vary the character of the metal in regard to softness, or machining quality, at the same time increasing the strength and

* The September record of two Isabella furnaces at Pittsburg, one of which is operated on the Gayley dry-air blast and the other on ordinary blast, is interesting, says The Iron Age. No. 1 furnace, with the Gayley refrigerating plant, made a ton of iron with 1,939 pounds of coke, while No. 3, using ordinary blast, required 2,339 pounds, a lowering of the coke consumption in favor of the Gayley dry-air blast of 400 pounds per ton of iron. No. 1 furnace made 413 tons of iron per day, as compared with 362 tons for No. 3, a gain of 51 tons per day. It should also be noted that No. 1 was running on Bessemer pig and No. 3 on basic, the former carrying 0.5 per cent of silicon more, so that iron made in No. 1 should really have used more fuel.

* Electrical World.

ductility of individual ladies of iron drawn from one common source.

ELECTRO-METALLURGY.

Wonderful progress is being made wherever cheap power from water-falls is obtainable in all branches of electro-metallurgy. In Europe they are actually making steel at various places in electric furnaces in a commercial way. A commission of experts was appointed by the Canadian government to visit Europe and study these methods, and it is now reported by Vice Consul General Gorman, of Montreal, that the Dominion government has appropriated $15,000 for making experiments with the electric process of smelting ores and manufacturing steel at Sault Ste. Marie, and the Consolidated Lake Superior Co. will furnish a building and dynamo capable of supplying 400 electric horse power for four months free of charge. All kinds of ores will be experimented with, and important results are expected to be obtained.

Great possibilities for Canada underlie the inauguration of a cheaper process for manufacturing pig iron and steel than is now in use. Ontario is dotted with ore bodies, the development of which is at present prevented by lack of cheap fuel. There is coal in the eastern and western parts of Canada, but the cost of conveying it to points where coke is needed for smelting purposes is prohibitive. On the other hand, there are a great many water powers throughout the provinces of Quebec and Ontario where electricity can be developed and utilized. If the electric system proves to be commercially feasible Canada is looking for the inflow of a large amount of capital and considerable mining development.

The Kjellin electric steel furnace at Gysinge, near Stockholm, Sweden, has been in operation since 1899, and it is claimed the process will bear comparison with the crucible and open-hearth furnaces in production on a large scale. The record shows that about 5,000 kilos of ingots are cast in twenty-four hours, or a little over 12,000 pounds. This furnace is chiefly employed in the regular production of tool-steel. The specialties manufactured at the Gysinge works are drills and chisels, forged stamping tools, steel forgings and forged steel for gun barrels, magnets, etc. The special qualities of this steel are its great elasticity, absolute homogeneity, softness, and the high proportion of carbon, together with its excellent magnetic properties.

The magnitude of the metallurgical industries of this country is truly amazing, but time will not permit me to give you statistics except in a very limited way.

It is stated that we are turning out 41 per cent of all the steel made in the world to-day, and still we are not making enough for home consumption. The imports of iron and steel for the last fiscal year exceeded $23,000,000.*

Even in secondary or subsidiary operations, which do not attract general attention, we hold a leading position among the civilized nations. Let us consider for a moment the case of the galvanizing and tinning processes, and we will find amazing figures of tonnage.

In a recent article by Charles F. Burgess in the Electro-Chemical and Metallurgical Industry on "The Action of Acids on Iron and the Use of the Acid Pickle," the following interesting statement appears: "Pickling constitutes an essential step in the well-known galvanizing process. Prior to immersing the sheet metal in the molten zinc it must be freed from scale and other oxides, and this is most satisfactorily accomplished by the use of the acid dip. To show something of the magnitude of this operation alone it may be estimated that since 60,000 tons of zinc per annum are used in this country for galvanizing, the area of surface which is thus protected is approximately equivalent to seventy square miles, or 40,000 acres. The area which must be pickled in the manufacture of wire and sheet metal probably largely exceeds even this. Statistics show that about 1,500,000 tons of iron and steel wire were produced in 1903. Such an amount of iron in the form of wire possesses over 100 square miles of area, and since the process of pickling must be repeated several times during the operation of drawing, the pickle area is unquestionably larger than this amount. From figures taken from the United States Census Report for 1900 about 20,000,000 pounds of tin were used for the production of tinned sheets, and this again represents a second area of about 140 square miles which must be pickled, not once, but twice."

I call attention to this statement in order to show the magnitude of galvanizing and tinning operations in the United States.

A comparatively new method of pickling iron castings to remove sand is to immerse them in a pickling bath containing hydrofluoric acid and water. Hydrofluoric acid dissolves sand while sulphuric acid dissolves the iron and does not affect the sand, merely loosening it. Experiments which I made some years ago in pickling cast-iron test bars in both acids showed that the sulphuric acid pickle caused a loss in strength and ductility of the bars averaging nearly ten per cent, while bars pickled in hydrofluoric acid were not appreciably weakened thereby.

THE METAL OF THE FUTURE.

A recent dispatch from Washington to the Iron Age says: "The production of aluminium in the United States has increased nearly ten fold in as many years, according to the annual report of the U. S. Geological Survey for 1904, which has just been completed. Two reasons explain this phenomenal growth—economic production, which has initiated low prices, and increased consumption, especially in the electrical industry. The output of 1904 was 8,600,000 pounds as compared with 7,500,000 pounds in 1903. When it is remembered that the industry dates its beginning from 1883, in which year the production was 83 pounds, its rapid development will be appreciated. It was not until 1891 that the output reached 100,000 pounds, but from that date the output has been phenomenal.

"Aside from the electrical industry, in which aluminium is gaining favor as a substitute for copper conductors for the electric transmission of light and power, there has been expansion in other directions. The steel industry has become an important consumer of aluminium. Usually from two to five ounces of aluminium are employed per ton of open-hearth steel made, and from six to eight ounces for Bessemer steel. If every ton of steel manufactured in the United States in 1904 had been subjected to this treatment there would have been about 5,000,000 pounds of aluminium consumed.

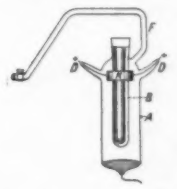
"Among other uses of aluminium may be mentioned parts of looms and other vibrating or moving machines, household and military utensils, lithographic plates, alloys with copper, zinc, and other metals, motor-car fittings, chemical vessels, etc."

A practical method for plating aluminium on iron would be a valuable discovery. In this connection I cannot help alluding to the fraud that was perpetrated upon the city of Philadelphia some years ago, when thousands of dollars were paid ostensibly for plating the iron work of the great tower on the City Hall with aluminium. It was claimed that this light-gray colored metal was heavily plated on all the iron work and that it would retain this color, closely resembling the stone base of the tower, indefinitely without further attention. The black appearance of the iron of the tower, and its serious injury by reason of oxidation, is a sufficient proof, if such were needed, of the falsity of these statements. I believe I am correct in saying that there was no known method by which the iron could have been protected by a galvanic coating of aluminium at that time, and I doubt if it would be possible even at this day. Aluminium being a highly electro-positive metal does not lend itself to the process of electro-plating.

* The production of pig iron in the United States, according to the annual statistical report of the American Iron and Steel Association for the year 1904, was 16,497,033 gross tons. The latest estimates indicate that the furnaces are now making pig iron at the rate of nearly 20,000,000 tons a year. Ten years ago the production was considerably less than half this amount.

THE GENERATION OF OZONE BY MEANS OF ULTRA-VIOLET LIGHT.*

THE first one to discover that ultra-violet light is capable of ozonizing oxygen was Lenard. He noticed that if the light from a spark gap were allowed to pass



through quartz plate (pervious to ultra-violet rays) and to impinge on oxygen, ozone was generated. If, however, a substance impervious to ultra-violet light was interposed, no such action took place. Goldstein noticed that the ozone odor existed on the outside of Geissler tubes through which a discharge was passing, only, however, if the tubes were partly of quartz. He attributed this to the action of ultra-violet rays, and, in all probability, the formation of ozone on the inside of the tubes also was due to the ultra-violet light. Warburg noticed that in such discharges as those through the Siemens ozone tube, for instance, ultra-violet light and kathode rays occurred, and he rightly attributed the generation of the ozone to the presence of these rays. Warburg and Regeuer measured on the one hand the volumetric contraction of pure oxygen when subjected to ultra-violet rays in the quartz tube of their ozonometer and, on the other, the volumetric expansion of strongly ozonized oxygen under the same conditions. From their results, they came to the conclusion that, in addition to the ozonizing action of the rays, a deozonizing action was also at work, and that the relative rapidity of the two processes under given conditions was fixed.

In order now to determine the conditions under which ozone is generated by means of ultra-violet light, the following experiment was carried out by the authors: For their light source, a specially-constructed mercury vapor lamp was employed (see figure). This mercury vapor light, rich in ultra-violet rays, was found to be best suited for the purpose. The lamp consists of an outer glass cylinder, *A*, connected with the exhaust pump by means of the tube, *F*, and an inner tube, *B*, of quartz glass, which has double walls and is exhausted. At *D* and D_1 platinum wires are sealed in, to which is attached the anode, *K*, consisting of an iron ring surrounding the quartz tube. In the bottom of the lamp a small quantity of mercury constitutes the kathode. The whole lamp is covered by an inverted glass bottle whose bottom has been removed and through which, by means of a syphon, a continuous stream of water is sent. The purpose of the water is to reduce the temperature within the lamp, so as to diminish the density of the mercury vapor, and so favor the generation of ultra-violet light. It was found necessary to still further reduce the heat effect in order to obtain satisfactory results. To this end, a glass cooler was introduced, by which running water was led through a tube near the quartz tube, and so reduced the temperature of the latter.

The oxygen to be used was generated electrolytically from dilute sulphuric acid, and chemically separated from any free ozone and traces of hydrogen. It was then passed through the quartz tube, subjected to the ultra-violet light, and separated by a simple chemical process from the ozone generated.

The chief factors noted which determined the amount of ozone obtained from a given amount of oxygen, were the following: The temperature of the gas, the light intensity of the lamp, the rapidity of the stream of oxygen, and its purity.

I. THE EFFECT OF COOLING THE OXYGEN.

Owing to the rapidly increasing rate of disintegration of ozone with rising temperature, the effect of cooling the gas while exposed to the rays of the lamp was naturally marked. Without passing the stream of cold water through the cooling tube, the minimum temperature, in spite of the double-walled exhausted tubing, was 270 deg., at which, of course, as is known, ozone does not exist. If, however, the glass cooler was put in operation, very appreciable quantities of ozone were generated.

The following tables will show the results of the reduction of temperature. The trials were made at intervals of fifteen minutes. The first table shows the results with cold water running through the tube, and the second the results with another liquid cooled by a freezing mixture. In each table the column headed No. gives the trial number, the columns T_1 and T_2 the temperatures of the liquid on entering and leaving the cooling tube, the column Mg.O_3 the weight of ozone generated, and the column Per cent O_3 the per cent of ozone in the oxygen.

TABLE I.

No.	T_1.	T_2.	Mg. O_3	Per Ct. O_3
1	1°	2°	0.434	0.194
2	1°	2°	0.430	0.199
3	1°	2°	0.434	0.194

TABLE II.

No.	T_1.	T_2.	Mg. O_3.	Per Ct. O_3
1	−10°	−2.5°	0.545	0.244
2	−10°	−2.5°	0.576	0.258
3	−10°	−2.5°	0.500	0.237

It is clearly seen, therefore, that lowering the temperature of the oxygen greatly increases the gain in ozone.

II. INFLUENCE OF THE LIGHT INTENSITY.

Keeping the cooling and the stream of gas constant, the intensity of the light was altered. It was found that the gain in ozone at first increased, but beyond a certain point decreased again. It seems likely that this decrease was due to increased heat generated, which, as we have seen, counteracts the force of the ultra-violet light.

III. INFLUENCE OF THE VELOCITY OF THE STREAM OF OXYGEN.

We remarked on the cooling influence of the gas on the quartz tube. It was to be expected, therefore, that by increasing the stream of oxygen the absolute quantity of ozone generated would increase; first, because the cooling effect on the tube is thereby increased, and second, because the ozone generated is carried off before having time to become heated and so destroyed. The percentage of ozone, however, would naturally decrease. The following table verifies the suppositions:

No.	Mg. O_3.	Per Cent O_3.
1	0.382	0.253
2	0.362	0.249
3	0.528	0.230
4	0.540	0.234
5	0.508	0.201
6	0.571	0.192

In doubling the stream (from two to four amperes) the amount of ozone generated very nearly doubled also, while the percentage was only four-fifths of its first value. The effect of passing oxygen in combination with a certain amount of water-vapor through the tube was also tried, without definite results, however.

It was found then, from the experiments made, that generation of ozone from oxygen took place if the temperature of the gas was not too high. In case the temperature exceeds 270 deg. there is practically no such generation, for then the reaction

$$3O_2 \rightleftarrows 2O_3$$

takes place from right to left due to the heat, much faster than from left to right due to the influence of ultra-violet light.

The results of the experiments seem only to confirm the opinion of Warburg and others that the generation of ozone in the Siemens ozone tubes is due to the ultra-violet light. The now accepted statement that the earth's atmosphere absorbs the ultra-violet rays of the sunlight, leads us to conclude with Lenard, that ozone is generated in the upper atmospheric layers and when it sinks lower it comes in contact with oxidizable substances and disappears.

At present further improvements in the apparatus with a view to eliminating as much as possible the heat disturbances, are being made, and some preliminary experiments point to the possibility of increasing greatly the quantity of ozone obtainable in this way.

* From an article by Franz Fischer and Fritz Braehmer in Die Physikalische Zeitschrift, September 15, 1905.

THE DIMENSIONS OF THE MARINE STEAM TURBINE.*

THE DETERMINATION OF THE PRINCIPAL DIMENSIONS OF THE STEAM TURBINE, WITH SPECIAL REFERENCE TO MARINE WORK.

By E. M. SPEAKMAN, Associate Member.

IN designing any turbine installation, the first and most essential step is to estimate the highest suitable speed of rotation, in order that the turbine may be made as small as possible for any given efficiency. While there is now no great difficulty in accurately determining the proportions of turbines and propellers to insure certain results, with ample confidence to enable a stiff guarantee to be made both for speed and economy, the principal dimensions involve considerable calculation, and much attention must be devoted to the efficiency of propulsion if the best results are to be obtained.

Knowledge of propulsive efficiency, and all its component values for various classes of work, is essential for calculating propeller dimensions, and thereby arriving at the highest revolutions attainable; for it is only when the rotary speed is settled that the best compromise of turbine dimensions, chiefly in the matter of blading arrangements, can be determined.

Turbine efficiency and propeller efficiency must be considered separately, and also together, because it may be found that the use of revolutions somewhat below the maximum obtainable will increase the combined efficiency; while, on the other hand, to obtain certain advantages in weight and space, this efficiency may be slightly sacrificed at the highest speed; and it is necessary to know the effect of such modifications on the design and performance. Roughly, the weight of the turbines will vary inversely as the square of the revolutions, while the economy of the turbine will remain almost constant if designed for the same internal conditions; the efficiency of the propeller will be slightly improved as the revolutions decrease, and the diameter is made greater.

In electrical work the design of generators almost invariably admits of very convenient speeds, but in marine work the size of propeller necessary to avoid cavitation imposes a much lower limit, with which the size of the turbine is greatly increased. The minimum size of propeller required to avoid this phenomenon (and its attendant inefficiency due to increased slip, and consequent loss of thrust at the higher powers) must be calculated at the beginning of any design, as it is almost impossible to assume certain revolutions, and later on to design a propeller to suit.

Cavitation is partly the result of attempting to obtain too much work per square foot of blade area, and partly of excessive peripheral speeds. It has been found, by bitter experience occasionally, that there is a narrow limit to the tensional pressure possible on the water, per unit of projected area, beyond which the propeller drops very rapidly. This pressure is approximately from 10 pounds to 12 pounds per square inch at a depth of 12 inches below the surface, and to reduce the total thrust to this sufficient blade area must be provided, which, in conjunction with certain practical proportions, necessitates a certain size of propeller, thereby limiting the revolutions.

Friction and slip constitute the normal losses in all propellers, and augmented resistance must also be taken into account. This latter loss, however, is materially reduced with the smaller diameters of propeller found in turbine work. Comparing the "Manxman" with the "Ulster"—a Holyhead mail boat of similar speed and power—the total disk area of the twin propellers of the latter is 226 square feet (for two 12-foot diameter propellers), while that of the "Manxman" is only about 80 square feet. If the thrust deduction is proportional to the absolute area of the disturbance of the stream lines at the stern, the effect on the "Ulster" will be far greater than on the "Manxman"; but this action is, to some extent, affected by the intensity over the disturbing area, which again is modified by the proximity of the propellers to the side of the vessel, this being less in turbine work. The disk area in H. M. S. "Velox" is less than half that of the propellers in ordinary destroyers of the same power and speed. Cavitation is a preventable loss, and its presence on many vessels with insufficient blade area may be deduced from the falling off of the thrust curve, and the rapid rise in the slip curve, above a certain speed.

From the analysis of numerous trials it appears that the pressure per square inch of projected area, when reduced to 12 inches immersion of tip, due to the effective thrust is approximately 1 pound for every 1,000 feet per minute of circumferential velocity of blade tips. For a screw of a given pitch ratio, working at its maximum efficiency, this velocity should be proportional to the designed speed of the ship; and at full speed the pressures seem to have hitherto been about 5 pounds per square inch for slow cargo vessels, from 6 pounds to 7 pounds for ocean-going mail steamers, and from 7.5 pounds to 8.5 pounds for cross-channel steamers; in cruisers and battleships they vary from 8 pounds to 10.5 pounds in some recent notable instances, and in torpedo craft from 9 pounds to 11 pounds. At about 9 pounds—rather less possibly—the lowest suitable limit is reached for turbine screws; from 10 pounds to 11 pounds may be more usual in fast vessels; and though even from 12 pounds to 14 pounds has been known, pressures over about 11 pounds always seem to be accompanied by low efficiencies. In large ocean-going vessels, which may be delayed by head winds and seas, a much lower designing pressure should be used; but in destroyers, as suggested above, something may be sacrificed at the maximum speed to obtain other advantages. The above pressure is worked out as mean pressure, as there exists no method of determining the local intensity per square inch, though the tendency of the distribution may be assumed in some cases. The only published results are in Barnaby's papers on the trials of H. M. S. "Daring," but they are very inconclusive in many ways. Fig. 1 is submitted with much diffidence, merely as an illustration of the values of this limiting pressure.

The maximum peripheral speed of tip ever used, I think, was 12,400 feet per minute in H. M. S. "Viper"; in H. M. S. "Velox" it is about 11,650 feet, and in the "Londonderry"[1] it is about 11,760 feet; but many vessels have been below 9,000 feet, which is quite normal for ordinary destroyer practice.

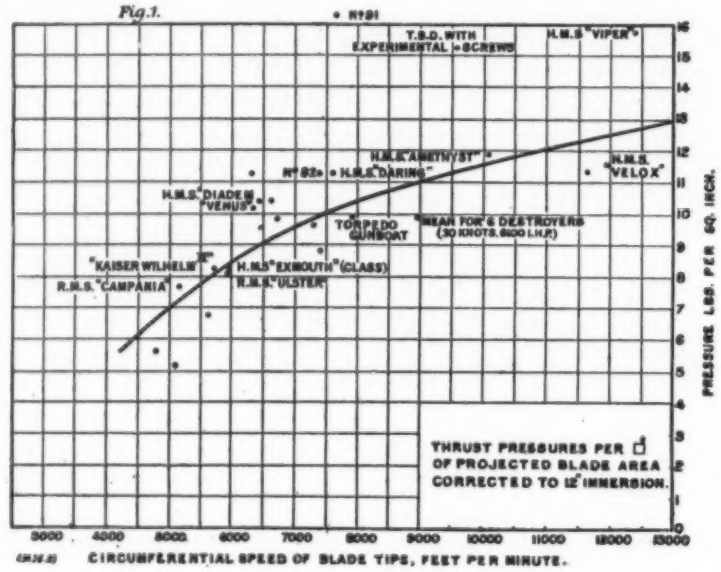
The pitch ratio for turbine propellers has been purposely made considerably finer than usual. Thus the pitch ratio for the "Emerald" was about 0.6; in Channel steamers and cruisers of from 18 to 25 knots it has varied from 0.8 to 1, and in torpedo craft from 1 in H. M. S. "Velox" to 1.35 in H. M. S. "Viper" and 1.6 in H. M. S. "Cobra," the latter vessels having one, two, and three screws per shaft respectively, driven by identical turbines, the approximate revolutions at full speed being 900, 1,200, and 1,050, for 27, 36, and 31 knots respectively on trial.

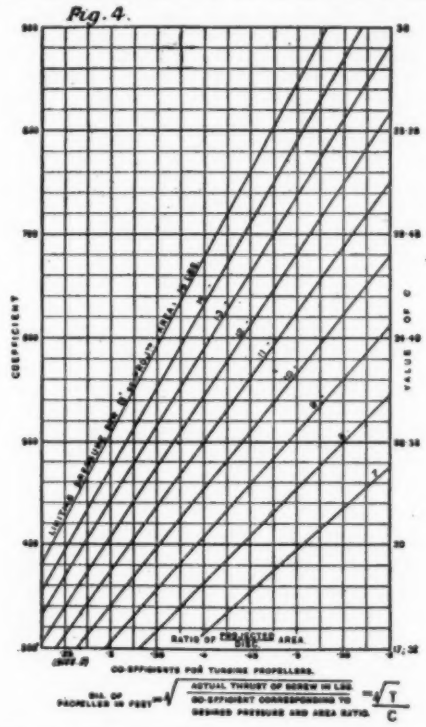
The percentage of slip has varied from 28 per cent in H. M. S. "Viper" down to about 14 per cent in the "Viking"—Channel steamers usually having about 17 to 24 per cent. For large ocean-going vessels about 16 to 20 per cent may be used with due regard to other considerations of propeller efficiency. The section of the blades should be carefully designed in order to try to obtain a shape that will enable as high a mean pressure as possible to be adopted. Recent experiments in the model tank at Washington* seem to show that a symmetrical section, as shown in Fig. 2, will materially increase the pressure at which cavitation commences, and also demonstrate that in fine-pitch high-speed screws the back of the blade should receive almost as much attention as the face. This, as the author is well aware, is no new idea; but there have been repeated indications, especially in the trials of ordinary torpedo-boat destroyers, that while the gain may not be great, it is sufficient to merit attention. Mr. Parsons has advocated a 10 per cent reduction of pitch at the blade-tip in order to avoid excessive local thrust, which might induce early cavitation; but there seems to be no advantage from departing from a true screw. The tendency of late years, in reciprocating engine practice, has been to increase the ratio of projected to disk area from the 0.2 of Froude's classic screw, and the 0.22 to 0.26 of naval practice, to about 0.33; destroyer practice is included between this and 0.37, or even 0.4, at which point turbine practice may be said to commence. In this even from 0.5 to 0.56 has been used; but beyond about 0.53 blade interference becomes excessive, and to obtain greater area a larger diameter must be used.

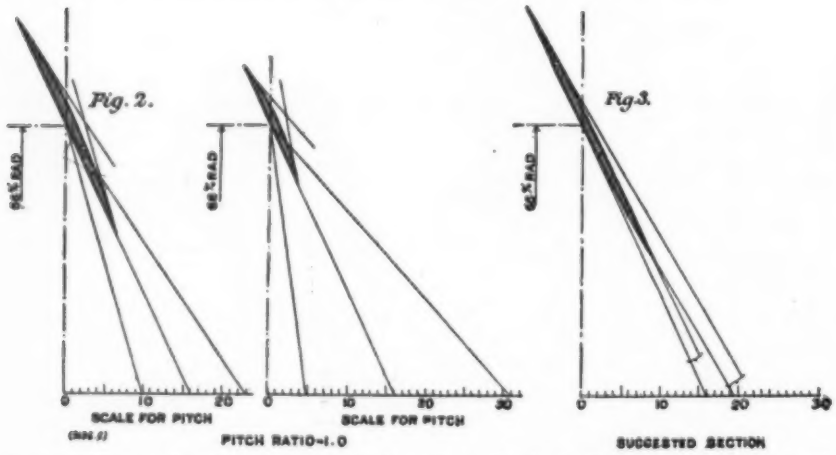
The best form of blade is still undetermined. In the photograph which is exhibited of the stern of the "Lorena" will be seen the usual shape adopted, and experience seems to show that this almost circular shape, with the area disposed symmetrically on each side of the center line, and with the generating line of the screw at right angles to the axis, gives as good results as any form.

I find that the following formula will give the diameter of a turbine propeller with considerable accuracy when the effective thrust along the shaft is known, and this must be calculated in any case if the steam balance of the turbine is to be good:

$$\text{Diameter of propeller in feet} = \sqrt{\frac{\text{Effective thrust in pounds}}{\text{Coefficient}}} = \frac{\sqrt{T}}{Q}$$







* Paper read before the Institution of Engineers and Shipbuilders in Scotland on October 24.

* See D. W. Taylor's paper, American Society of Naval Architects, 1904.

This coefficient has been deduced from the limiting pressure per square inch, and the ratio of projected to disk area, and is given in diagram form in Fig. 4, where the full coefficient 400—900 is given in the left-hand scale, and values of C or $\sqrt{\text{coefficient}}$ appear in the right-hand margin. The square root is only extracted for simplicity, whereby such coefficients as 30 are obtained for H.M.S. "Viper"; while for the "Manxman," that for the center screw is 26.4, and for the wing screws about 28.75. For large ocean-going vessels with lower designing pressures these values will be rather less—perhaps about 22.

The following table gives a few propeller dimensions and the corresponding coefficients, which the author trusts will be of use in designing high-speed screws.

TABLE I.—PROPELLER DIMENSIONS.

VESSEL.	TYPE.	Number of Screws.	Diameter.	Pitch.	Pitch Ratio.	Speed of Tip.	C (Approximate).
			ft. in.	ft. in.		ft. per min.	
Turbinia	Experimental	{3 / 3	1 6 / 2 4	2 0 / 2 4	1.33 / 1.0	1",880 / ..	29* / 31.3*
Viper	Torpedo-boat destroyer	8	3 4	4 0 fowd. / 4 6 aft.	1.2 / 1.35	12,350	30.1
Amethyst	Third-class cruiser	3 {1 / 2}	6 6	6 6 / 5 10	1.0 / 0.898	9,200 / 10,000	26.8
Manxman	Cross-Channel steamer	3 {1 / 2}	6 2 / 5 7	5 7 / 5 0	0.906 / 0.896	10,270 / 10,760	28.4 / 28.75
Londonderry	Ditto	3 {1 / 2}	5 0	4 6	0.9	10,550 / 11,310	30.8
Dieppe	Ditto	3	5 3	..	..	10,100 / 10,400	29
Carmania	Atlantic mail	3	14 0	13 0	0.928	8,125	21
Victorian	Intermediate	3	8 9	..	..	7,150	24.05

* These C values are calculated from the same effective thrust in each case.

Compared with above values of C, reciprocating-engine practice gives such figures as: R. M. S. "Lucania," 16.5; H. M. S. "Diadem" class, 17.5; H. M. S. "Exmouth" class, 19; and standard 30-knot destroyers of 6,100 horse-power, 20.8, all of which have much lower ratios of projected to disk area, and therefore a larger diameter and smaller C for a given power. Regarding these figures, it must be understood that C is an approximation only, and owing to the difficulty of obtaining the actual power in each shaft in every case, cannot be considered as absolutely accurate. Probably, however, the error involved is under 2 per cent. It seems likely, to some at present undeterminable extent, but within narrow limits for each class of vessel, that the propeller efficiency is proportional to the coefficient C and this seems to be borne out by the trials of the "Manxman" and the "Londonderry."

Effective thrust is a somewhat subtle subject, and our knowledge of propulsive efficiency is by no means what it ought to be. These considerations will undoubtedly be brought into far greater prominence in the near future, and it is by no means improbable that the Admiralty or certain private owners will require some definite standard in this, just as coal or steam consumption is regulated at present. The more propeller efficiency is studied and understood the greater will be the improvement in the design of turbine installations for marine work; the turbine itself is a comparatively secondary consideration, and while at present propeller dimensions for turbine steamers can be quite as closely determined as those for ordinary work, the exact proportions must necessarily largely remain subject to modification from actual experience.

While a general tendency has been very noticeable toward increasing the propeller diameter and reducing the revolutions, there will, of course, be some point, at present undetermined, at which the triple screws used in turbine work will be distinctly less efficient than ordinary twin screws. Very largely, this is the case at present with triple screws driven by piston engines, on account of excessive thrust deduction and interference; but probably before this point is reached the weight of the turbines will have prevented its adoption.

Having obtained the diameter of the propeller and the revolutions possible, the design of the turbine can then be undertaken; but for this no formulæ exist at present, such as are met with in reciprocating-engine practice.

Restricting attention to the design of the Parsons type of turbine, a few notes on the action of the steam among the blades may be of interest. Expanding through a definite range of temperature and pressure, steam exerts the same energy, whether it issues from a suitable orifice or expands against a receding piston. Two transformations of energy take place in the steam turbine—first, from thermal to kinetic energy; secondly, from kinetic energy to useful work. The latter alone presents an analogy to the hydraulic turbine, the radical difference between the two lying in the low density of steam compared with water, and the wide variation of its volume under different temperatures and pressures.

Fig. 5 gives a sectional elevation of a marine turbine blading arrangement, and though this is only for a high-pressure cylinder, the principle is exactly the same throughout. The expansion, which is approximately adiabatic, is carried out in this annular chamber from A to B, which essentially resembles a simple divergent steam nozzle, but with this difference: that whereas in a nozzle the heat energy of the working steam is expended upon itself in producing high velocities, in the Parsons turbine the total expansion is subdivided into a number of steps, in each of which a certain dynamic relationship between jet and vane is maintained. The expansion of steam at any one stage is typical of its working throughout the turbine. Each stage consists of a ring of stationary blades which give direction and velocity to the steam, and a ring of moving blades that immediately convert the energy of velocity into useful torque. The total torque on the shaft is due to the impulse of steam entering the moving blades and to reaction as it leaves them, this process being repeated throughout the turbine.

Leakage past the revolving portion of the spindle at D is almost entirely prevented by the ingenious form of frictionless packing, shown on a larger scale in Fig. 6. The fine clearances and the sudden increase of section have the effect of alternately wire-drawing and expanding the steam, so that at successive grooves it becomes increasingly difficult for the steam to leak past the fine clearances. In the astern turbines a radial form of packing, depending on fine tip clearances, must be adopted owing to the difference in expansion between spindle and cylinder. Numerous varieties of these forms of packing exist, some of them being extremely efficient in their action.

The laws governing the best theoretical velocity of steam and blades are similar to those for water-turbines, but in practice some modification is necessary, and the best ratio of blade speed and steam speed is still a matter of opinion. The ideal condition for impulse turbines occurs when the peripheral velocity of the buckets is one-half that of the jet; or in reaction turbines, when it is equal to it.

The Parsons turbines, however, have been built with $V\,t$ (Fig. 7) varying from 0.25 to 0.85 of $V\,s$, where $V\,t$ represents blade velocity at mean diameter, and $V\,s$ the steam speed due to expansion across the row in question. A very usual ratio in electrical work for large units has been $\frac{V\,t}{V\,s} = 0.6$, but this involves a greater number of rows than is possible in marine work, and the ratio must be reduced. These ratios need very careful calculation. The steam consumption must be accurately known in order to proportion them correctly throughout the turbine, and the necessity (which is inevitable with the present form of calking-piece) of having the same area of openings in so many rows, while the steam volume increases so rapidly, adds to the difficulty of close calculation. The potential energy of the steam, corresponding to the "head" in water turbines, can easily be calculated for given pressure differences:

$$\text{B. T. U.} \times 778 = \text{energy in foot-pounds per pound of steam} = e.$$

$$V\,s = 8\sqrt{e} = 223\sqrt{\text{B. T. U.}}$$

For a given blade velocity it is obvious, then, that the speed ratio between jet and vane must affect the number of stages, and the greater the ratio of $V\,t$ to $V\,s$ the greater will be the required number of rows—that is, to obtain the required $V\,s$ at each stage a smaller pressure drop per row is necessary, or *vice versa*.

The best blading arrangement, scientifically and commercially, is the result of much theory and practice. The mean diameter is an arbitrary dimension capable of wide variation without affecting the efficiency, provided that the number of rows is correct; it is found by assuming, from experience, a blade velocity, whence

$$\text{Mean diameter in in.} = \frac{\text{Blade velocity in ft. per sec.} \times 228}{\text{R. P. M.}}$$

To arrive at the corresponding number of rows, the revolutions being given, the ratio of $V\,t$ to $V\,s$ must be settled, from which the steam speed can be obtained; it is a convenient assumption at the beginning of any design to consider the turbine as parallel throughout and of constant efficiency, and to design on this basis. The number of rows, N, on one diameter can be found by working out the British thermal units necessary to give a certain steam speed at each row (see Fig. 8), the available energy divided by the energy it is desired to abstract at each row will give the number of rows required. This result may be arrived at by various ways, but the principle involved is the same in each case.

(To be continued.)

Fig. 5.

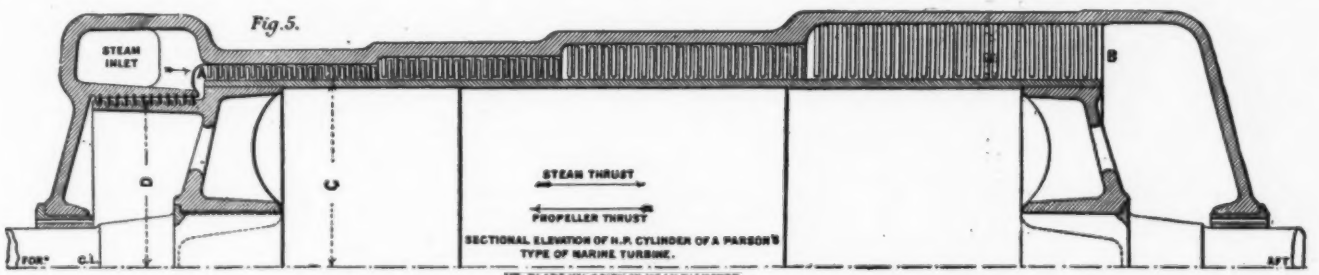


Fig. 6.

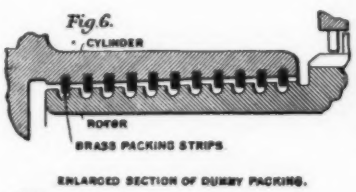


Fig. 7.

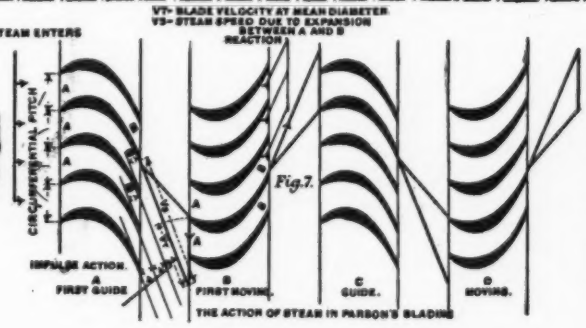
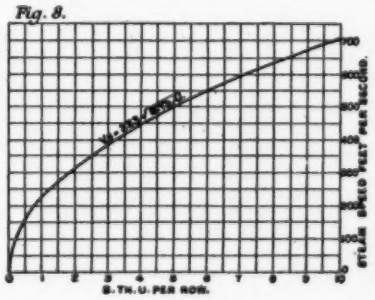


Fig. 8.



THE HOUSING PROBLEM IN MANCHESTER.

AT the New Islington Hall, Manchester, Councilor Fildes, chairman of the sanitary committee of the city council, and formerly the chairman of the housing subcommittee, has explained what has already been done in Manchester toward a solution of the housing problem, and pointed out how much still remains to be done. The number of one-roomed tenements in Manchester, he said, was not great, and the back-to-back houses, which were of a very bad type, were far more common. It was among these houses that the detail work of the unhealthy dwellings committee was, until recently, almost entirely carried on. During the last twenty years the number of such houses closed, closed and demolished, or closed and added to other houses, was 6,704. The number of two-roomed tenements at the last census, however, was 6,869, so that there was still plenty of work to do in connection with property of this class. The death rate in a certain area in Hulme was 40 per 1,000, and in an area in Ancoats 36 per 1,000—a state of things which beyond all question must be altered. More drastic powers were needed to enable local authorities to purchase slum property at slum values, and he hoped that before long legislation would be promoted with that object. At present the

minimum width of streets in Manchester was 36 feet, and he thought it would be wise to have this materially increased. Streets were not laid out in the centers of cities where land was dear, consequently what had been perpetuated in the center need not be continued in the outskirts.

On the outskirts building operations were in progress which threatened to create new slums in the future. Up to the present no distinction appeared to have been made in by-laws between the center of a city where land was dear and the outer fringe or undeveloped portions toward the boundaries where land could be obtained at a comparatively low rate. As a consequence by-laws had to be considered with regard to their effect upon building operations in the center of large cities, and builders under more favorable conditions on the outskirts took advantage of the prescribed minimum. To remedy this defect he suggested that by-laws in degrees should be framed. By aid of the lantern Mr. Fildes showed pictures of several condemned areas as they formerly existed, in contrast with the tenement dwellings and cottages which the corporation have built in various parts of the city. He mentioned that the total amount spent by the corporation in housing schemes under the Laborers' Dwellings Improvement Act since it was adopted in 1889 was £416,432, and that an additional sum of £35,500 had been spent in work under local acts.

ON CHEMICAL METHODS BY WHICH THE EGGS OF A MOLLUSK (*LOTTIA GIGANTEA*) CAN BE CAUSED TO BECOME MATURE.*

By JACQUES LOEB.

(From the Herzstein Research Laboratory at New Monterey.†)

Two years ago I published the fact that I was able to produce larvæ from the unfertilized eggs of certain limpets (*Acmæa, Lottia gigantea*) by submitting these eggs for about two hours to hypertonic sea-water of a certain concentration; but that I was not able to produce larvæ by fertilizing the eggs of the same females with sperm. Soon after I found my new method of artificial parthenogenesis, I tried it also on the eggs of limpets, especially *Lottia gigantea*. In cases where the treatment with hypertonic sea-water alone did not lead to the formation of parthenogenetic larvæ the combination of a treatment of the eggs of the same female with hypertonic sea-water and a fatty acid led in most cases to the formation of larvæ from the unfertilized eggs of Lottia. As a rule I proceeded in this way: I exposed the eggs for from 1½ to 2 hours to a mixture of 100 cubic centimeters sea-water and 17 cubic centimeters 2½ n KCl or NaCl and then five or ten minutes later for from 2 to 3 minutes to a mixture of 50 cubic centimeters sea-water, and 3 cubic centimeters n/10 butyric, valerianic, or capronic acid.

But even in this case the number of eggs which developed was always small and rarely exceeded a few per cent. The segmentation of the developing eggs was perfectly regular, but the larvæ, as a rule, lived not longer than two days. They began to disintegrate into several fragments as a rule the first day. In order to find out how they differed from the normal larvæ which arise from the fertilized eggs I tried at various times from April to the end of October to fertilize the eggs of Lottia with sperm. But while I always succeeded in producing artificial parthenogenesis in the eggs of Lottia, I practically never was able to fertilize the eggs with sperm. Occasionally an egg in many thousands was noticed to develop when sperm was added, but the resulting larva was always as imperfect and of no better or even of less vitality than the parthenogenetic larvæ.

The fact that the eggs could not be fertilized with sperm suggested the possibility that they were not mature and instead of waiting any longer for the period of maturity to arrive I decided to try whether it was not possible to cause the eggs to become mature by artificial means. I put eggs into mixtures of 50 cubic centimeters of sea-water to which 0, 0.5, 0.75, 1.0, 1.25, and 1.5 n/10 NaHO had been added, and added to each dish the same amount of sperm. None of the eggs which had been put into normal sea-water segmented or produced a larva. A few eggs were fertilized in the mixture of 50 cubic centimeters + 0.5 cubic centimeter n/10 NaHO, more developed in the mixture with 0.75 cubic centimeter NaHO, and a very large percentage was fertilized in 50 cubic centimeters sea-water plus 1.0 cubic centimeter n/10 NaHO. Eggs which were left in the same solutions without the addition of sperm neither segmented nor formed any larvæ. When the same amount of acid (HCl or CH_3COOH) was added to the sea-water no eggs were fertilized. It was therefore obvious that eggs of Lottia which could not be fertilized in normal or acidulated sea-water could easily be fertilized in alkaline sea-water.

The next question was whether the alkaline sea-water brought about the fertilization by modifying the egg, the spermatozoon, or both. It could be shown that the alkali rendered fertilization possible by modifying the egg. When eggs were put for several hours (4 to 6 hours) into a mixture of 50 cubic centimeters sea-water + 1 cubic centimeter n/10 NaHO and then put back into normal sea-water to which sperm was added, just as many—practically all the eggs—were fertilized as if the sperm were added to the eggs in the alkaline sea-water. When, on the other hand, the sperm was put into alkaline sea-water and was added afterward to eggs that had been in normal sea-water, not a single egg developed. It was therefore obvious that the egg underwent a modification in the alkaline sea-water by which it became ready to be fertilized. This conclusion was supported by the microscopic examination of the eggs. The eggs which remained in normal sea-water and could not be fertilized had an irregular outline and were surrounded by a chorion. The eggs which had been put long enough into alkaline sea-water and could be fertilized had become spherical and lost their chorion. While these changes occurred in alkaline sea-water they did not occur in normal sea-water. After the eggs had once become mature in alkaline sea-water they, of course, remained so when brought back into normal sea-water and left there.

Was this influence of the alkaline sea-water upon the maturation of the egg a chemical or a physical effect? The influence of temperature upon the rate of the process of maturation renders a decision possible. We know that an increase in temperature accelerates the velocity of chemical reactions more rapidly than it modifies any physical quality. Eggs of the same female were put in two dishes each containing 50 cubic centimeters sea-water + 1 cubic centimeter n/10 NaHO. One dish was kept at a temperature of about 18 deg. C., the other at 8 deg. C. At various intervals some eggs of each dish were taken out, put into normal sea-water of 18 deg. C. and sperm was added. It was found that the process of maturation occurred about twice as rapidly at 18 deg. C. as at 8 deg. C. The individual eggs of a female do not all become mature equally rapidly in alkaline sea-water, so that at first the number of eggs which can be fertilized increases until finally all are mature. Moreover it is possible that the eggs whose process of maturation has been started to some extent in alkaline sea-water may complete it, though slowly, in normal sea-water. I first determined the time the eggs had to remain in the alkaline sea-water until fertilization became possible. The solution used was 50 cubic centimeters sea-water + 1 cubic centimeter n/10 NaHO. I found that this time was in one experiment for eggs kept at 19 deg. 40 minutes and for eggs kept at 8 deg. 105 minutes. When the following day the relative amount of larvæ was counted in the various lots taken out at different intervals the result was as follows:

Time of exposure to alkaline sea-water.	Number or percentage of larvæ found in watch glass full of eggs.	
	at 18 deg.	at 8 deg.
40 min.	1 larva	0 larvæ
55 min.	about 6 larvæ	0 larvæ
83 min.	about 12 larvæ	0 larvæ
105 min.	10%	2 larvæ
130 min.	40%	about 6 larvæ
205 min.	over 50%	about 12 larvæ
270 min.	over 75%	5%
315 min.		10%

I do not lay any stress on those observations where only a few, half a dozen or a dozen larvæ, were found in a watch glass full of eggs, inasmuch as an individual larva might easily be overlooked. But we notice that while about 10 per cent of the eggs become mature after 105 minutes' stay in alkaline sea-water at 18 deg., the same percentage became mature only after about 315 minutes at 8 deg. The temperatures chosen for comparison are no extremes and are within the limits where life and development are normal. None of the control eggs kept in normal sea-water at 18 deg. could be fertilized. It therefore seems as if the effect of alkaline sea-water on the maturation of the egg of Lottia were chemical and not physical.

It can, moreover, be shown that oxygen is necessary for the maturation of the eggs of Lottia in alkaline sea-water. Eggs of the same female were distributed into three lots; one was kept in normal sea-water as a control, two others were put each into 50 cubic centimeters sea-water + 1.1 cubic centimeters n/10 NaHO. One of these latter solutions was exposed to a current of hydrogen for four hours. After that time the eggs kept in alkaline sea-water in the presence of oxygen were all mature and upon the addition of sperm all developed into larvæ; while the eggs kept in alkaline sea-water in the absence of oxygen were all immature and none developed upon the addition of sperm. The experiment was repeated several times and special precaution was taken to wash the hydrogen before it went through the sea-water containing eggs so as to free it from all traces of acid. I convinced myself by titration that this source of error was avoided. None of the eggs left in normal sea-water were fertilized, although they showed after twenty-four hours a beginning of maturation.

A simpler way of showing the influence of oxygen upon maturation was this, to put a layer of eggs at the bottom of a long test tube filled with alkaline sea-water which was closed tightly. When the eggs were left in such a tube for five hours no eggs or very few were found ripe and could be fertilized; while the eggs of the same female when left in the same alkaline solution, but in a shallow dish and in a very thin layer, were about all ripe and could be fertilized after the same time.

Since it was possible that the HO ions acted catalytically I expected that the eggs of Lottia would mature also in normal sea-water if they were kept long enough. While this is probably correct the eggs did not become mature in the experiments I have thus far tried, even if they were kept for 48 hours in normal sea-water. Some eggs were kept at 25 deg. for 6 hours in normal sea-water without ripening. The eggs became usually round after 24 hours and began to lose the chorion, but could not be fertilized.

The fact that very frequently during the last six months I was able to produce artificial parthenogenesis in the eggs of Lottia without being able to fertilize them with sperm, suggested the probability that the methods which cause artificial parthenogenesis must cause incidentally the eggs to ripen, since it did not seem likely that immature eggs could develop parthenogenetically. This supposition was found to be correct. Eggs of Lottia were put into solutions of 100 cubic centimeters sea-water + 18 cubic centimeters 2½ n KCl or NaCl and left there for from 40 minutes to 4 hours at a temperature of about 18 deg. C. When taken out from such a solution after about 1½ to 2 hours a small percentage of the eggs could, as a rule, be fertilized. KCl seemed to be a little more effective than NaCl and it should be stated that as a rule in experiments with hypertonic sea-water KCl is generally more effective also for the production of artificial parthenogenesis. Sodium acetate was a little better than NaCl, probably on account of the slightly alkaline reaction of the solution. When the eggs were kept too long in hypertonic sea-water they suffered and could no longer be fertilized.

These observations explain the fact that I was never able to cause more than about 5 per cent of the eggs of Lottia to develop parthenogenetically by treating them with hypertonic sea-water, the reason being that no more than that number were caused to become mature by this method. And, moreover, it explains the fact that the osmotic method of artificial parthenogenesis is not always successful in Lottia, since the hypertonic sea-water does not in all cases cause eggs to become mature. These observations on the influence of hypertonic sea-water on the process of maturation are of special interest since they seem to pave the way for the decision of another question that I have often alluded to in my papers on artificial parthenogenesis; namely, whether the hypertonic sea-water caused the development of the unfertilized egg by a merely physical or by a chemical influence upon the latter. At first I was inclined to assume that there existed a direct physical influence of the extraction of water from the egg upon the colloids in the egg and I used to discuss this possibility in my lectures more fully than in my papers, especially in connection with the work of Hardy. But at the same time a possibility of a chemical effect existed and could be accounted for by the fact that the loss of water on the part of the egg must alter the degree of electrolytic dissociation unequally for the different salts contained in the egg. One of the results might be a change in the concentration of the HO or H ions in the egg and this might lead to a catalysis of certain chemical processes. Since our experiments indicate that the influence of alkali upon the process of maturation is a chemical one, it is probable that the equal though weaker effect of the hypertonic sea-water upon the same process is also chemical. I intend to continue this line of inquiry.

It occurred to me to try whether a treatment of the eggs with a fat solvent, such as benzol, could not also cause the eggs to become mature. It was found, indeed, that when 1 cubic centimeter of benzol was added to 50 cubic centimeters of sea-water and an emulsion brought about by shaking the mixture, the eggs of Lottia, after having been exposed to this emulsion for from ¼ to ¾ of a minute, and put back to normal sea-water, became slowly mature within from 1 to 2 hours. If the eggs are left longer in this emulsion they undergo cytolysis. The benzol acted much better upon eggs that had been previously exposed for two hours to 100 cubic centimeters of sea-water + 16 or 18 cubic centimeters 2½ n NaCl than upon eggs that had been in normal sea-water, i.e., more eggs of the former were caused to become mature by the benzol treatment than of the latter. After the eggs treated with benzol had become mature they practically all developed when sperm was added. The eggs that had been treated with benzol matured in larger numbers in normal sea-water and in an abundant supply of oxygen than in sea-water through which a stream of hydrogen was carried. But the difference was not as striking as in the case of the eggs treated with alkaline sea-water. This may have been due, however, to the fact that the eggs mature much more quickly after treatment with benzol than during treatment with alkaline sea-water and therefore the initial quantity of oxygen present in the sea-water will last through a comparatively larger fraction of the time required for maturation in the former than in the latter case.

In view of the effect of benzol upon fats and lipoids I tried whether ether and esters (e.g., ethylacetate) did not act in the same way as benzol. The few experiments carried out thus far gave entirely negative results, though I do not consider them as final.

As far as the parthenogenetic development of Lottia is concerned, I may mention that the eggs that had matured in alkaline sea-water or in normal sea-water after benzol treatment never developed without the addition of sperm; nor was it possible to cause such eggs to develop by merely putting them for several minutes into 50 cubic centimeters of sea-water + 3 cubic centimeters of a fatty acid. In all the experiments on the artificial parthenogenesis of Lottia the treatment of the eggs with hypertonic sea-water formed an indispensable part of the procedure.

Through the application of the above-mentioned method it will be possible to utilize the material of Lottia with the same ease for at least six months of the year as has heretofore been possible only with the

* From University of California Publications.

† Through the munificence of Dr. Morris Herzstein, of San Francisco, a marine laboratory for biological research, has been built and equipped at New Monterey, Cal. The work of the Physiological Department will be carried on in both the Rudolph Spreckels Laboratory in Berkeley and the Herzstein Research Laboratory at New Monterey.

material of Echinoderms. The larvæ produced from the eggs caused artificially to mature rise to the surface of the water and seem to be entirely normal.

SCIENCE NOTES.

A source of considerable loss in the operation of steam plants, particularly large ones, is the insufficient size of piping, causing the pressure to be reduced between the boiler and engine, and imperfect drainage, which is an enemy both to economy and the life of the engine. In many of the newer plants, it has been found a great advantage to install large receivers to equalize the pressure and to collect the water before it reaches the engine.

As the study of weight led to the idea of atoms, so the study of volume and density led to our idea of molecules. These molecules, which might be described as constellations of atoms, were a necessity with Dalton's conception; but, in a binary compound, for instance, they might consist of two atoms or of twenty. Now, it hardly needs to be recalled that Gay-Lussac, and especially Avogadro, in following the volume relations of gases in chemical action, drew the conclusion that the molecules of gases occupy equal volumes under identical conditions. Thenceforward we had a reliable method for determining the relative weights of such molecules.

The position of any spot on the earth's surface can be ascertained in two ways: either by careful measurement by means of an accurate system of triangles from another spot already fixed, or by independent observations of the heavenly bodies and calculations from them, which give the precise latitude and longitude of the place. The former is suitable for positions inland, but entails much time and labor, and is only adopted when a perfect map is to be made, for which it is the indispensable foundation. The latter can be carried on from a ship, and in most circumstances only from a ship, because of the limitations of the methods of determining longitudes. Longitude can now be satisfactorily and rapidly ascertained in two ways—by the electric telegraph or by use of chronometers. The places served by the electric telegraph are still few, and its use is therefore restricted; but the chronometer has been in working use for more than a hundred years.

The discoveries on sleeping sickness ushered in by researches of Castellani, of the School of Tropical Medicine, have been confirmed and extended by Bruce and his collaborators of the sleeping sickness commission. The relation of the flies belonging to the genus Glossina to the transmission of the trypanosomes is being actively studied, and many important questions we must hope are nearing their solution in connection with this most fatal malady. A contribution has just come to hand from Gray and Tulloch with regard to the multiplication of the parasites in Glossina, indicating that the belief recently expressed is warranted, namely, that the parasites undergo a cycle of development within the insects. Of importance in their bearing on the question of the development of trypanosomes in other than their vertebrate hosts are the investigations of Schaudinn on *Trypanosoma noctuae* in Culex, those of Brumpt on certain trypanosomes of fishes which undergo their cycle of development in leeches, and those of Prowazeck on the rat trypanosome, which he has demonstrated undergoes development in the rat louse (*Haematopinus spinulosus*).

Of the many destructive agencies at work in the forests of the United States, fire holds first place, and the loss which it inflicts equals, if it does not surpass, that from all other causes combined. Insect hordes occasionally destroy large areas of valuable forest growth; wasteful and short-sighted lumbering methods, resulting from involved economic conditions, have brought about the rapid conversion of much of the finest timberland into unproductive barrens; and in the far West excessive and unrestricted grazing has seriously reduced the regenerative power of the forest and exposed vast areas to injury by flood and erosion. But great as is the damage from these causes, compared with fire they are of secondary importance. Further, it is to the fires which usually precede, accompany, or follow these other agencies that their most serious consequences are often due. Insect attacks often follow when fire has killed or reduced the vitality of timber; the cut-over timberlands of the Great Lakes and other regions would not present such a discouraging aspect had not fire killed the seed trees and young growth, which otherwise would have survived even the most pernicious logging; and in the forests of the West fire again is a potent source of difficulty in adjusting the conflicting claims of the grazing, timber, and water interests.

In 1901, Freidel made the surprising report of success in securing outside of the living plant a gas exchange similar to the photosynthetic action of chlorophyl. He was later unable to confirm his previous conclusions, nor were the subsequent results of Macchiata and Herzog concordant. Recently, Molisch has employed upon this problem the photobacterial method of Beijernick. He finds that the expressed sap of certain plants may for a time maintain photosynthetic activity, but since usually the sap loses this power when filtered through a Chamberlain filter, it is believed to be due to the presence of living plasmatic particles. Nevertheless, it is claimed that an exchange of gases characteristic of photosynthesis may proceed in a solution of the leaves of *Lamium album* dried crisp at 35 deg. C. and then "rubbed up" in water and filtered. The observation demands much further study, for it must be remembered that the test is by means of the liberation of oxygen, and Ewart has shown that some bacterial pigments may have the power of evolving oxygen. In the last-named case the gas evolved appears to be, as he states, "occluded oxygen absorbed from the air by the pigment substance excreted by the bacteria." It cannot be stated at the present time, however, as was assumed from Freidel's first work, that there is any enzyme concerned in the photosynthetic activity.

ELECTRICAL NOTES.

The discovery of Roentgen rays at once increased the claims of electricity to proper medical recognition. The demands for X-ray apparatus have kept the instrument makers busy from that time to this and the developments of the therapeutic uses of X-rays as well as the diagnostic uses have had the effect of overshadowing the rest of the applications of medical electricity so that they have been in danger of being forgotten by the general mass of the profession. The list of real gains in X-ray therapeutics is large and highly important. If we pass by the question of malignant disease, in which nevertheless X-rays may be of considerable value in prolonging life, we yet find a goodly list: rodent ulcer, lupus, psoriasis, chronic eczema, ringworm, sycosis, acne, pruritus, and leukæmia. All these may be confidently claimed as conditions in which X-rays give results of great value.

The maximum temperature which may be obtained theoretically by the combustion of carbon in oxygen is higher than that which has been attained in the electric furnace, but practical conditions place a greater restriction upon it. At high temperatures carbon cannot be consumed to CO_2, but rather to CO, and this gaseous product escapes rapidly and carries the heat away from the furnace. Further, it is impossible under practical conditions to supply pure oxygen, and in utilizing the atmospheric supply not only must the large quantity of accompanying nitrogen be heated, but the excess of air which must always be supplied also carries away a large amount of heat. The maximum temperature which has been attainable in the combustion of fuel in the gaseous, solid, or liquid form, from which volatile products of combustion are formed, probably does not exceed 2,000 deg. C., and even this value can be obtained only at a low efficiency and under most favorable conditions for the conservation of heat.

It is stated that the Continental Gesellschaft of Nuremberg has drawn up a complete project for a suspended monorail system analogous to the Barmen-Elberfeld road which is now operating successfully. The new line is intended to be run in the city of Berlin and will pass along some of the main streets and avenues. The total duration of the trip is to be 22 minutes, with stops on an average every 4.4 minutes. The smallest distance between stations is 2.8 minutes and the longest 5 minutes. A greater average speed is to be reached on the suspended road than is now used on the overhead and subway lines of Berlin, seeing that the cars are not obliged to slow up when going around curves in the case of the suspended system. The double overhead track will be supported either on each side of a T-shaped structure placed in the middle of the street, or else on a long beam support which passes across the street and is upheld at either side. The cars are to be about 50 feet long and will hold 85 persons, with smoking compartments, and will have a door at each end and one in the middle. The cars will be suspended about as in the Barmen-Elberfeld system. The trains are expected to transport 50 million passengers per year. Such a system is said to be more economical than other traction systems.

A great deal has been said by rival inventors as to the possibilities of wireless telegraphy, and some exaggerated claims have been made on their behalf which have led to counter-statements by some interested in other methods of communication. While, on the one hand, it may be fairly assumed that wireless telegraphy is not, under any circumstances, likely to supplant, or even to compete seriously with, inland methods of intercommunication, there is no doubt that there is a very distinct and important sphere of utility awaiting its further development. For intercommunication between ship and shore, and ship and ship, much has been done, although much remains to be done. For intercommunication between neighboring coasts there is also a possible future; but this depends almost wholly on the further development of the methods of syntony, or tuning. There appears to be no doubt that in cases in which the wave-lengths used on two systems differ to a considerable extent, a very marked degree of success has been obtained in the avoidance of mutual interference. Where the wave lengths, however, are not very widely apart in frequency, there is in each case a definite range within which interference arises, and simultaneous working is impossible. That the tuning methods will be improved there can be very little doubt. The progress that has been made between the year 1896, when it took a week to receive a few elementary signals over a distance of nine miles, and the present time, when such remarkable results have actually been obtained, is so great that it does not imply the possession of an unduly sanguine disposition if one ventures to predict further improvements, which may be expected to increase the freedom from mutual interference, the speed, and the reliability of this method of communication. It does not appear to be very probable that it will seriously compete with the highly-developed cable communication in the near future, although it may in many instances supplement that service.

ENGINEERING NOTES.

The proper and most convenient measure of boiler furnace efficiency would be the composition of the gases leaving it, as determined by analysis. According to the above definition, a furnace would not be a portion of some steam generating apparatus; for example, when a grate is located immediately under the boiler. In other cases, such as with many stokers, the furnace feature is only partially developed. With such fuel as anthracite coal or coke, a furnace would have a minimum value, and its maximum value would be realized with bituminous coal.

A collision recently occurred on the Uganda Railway, British East Africa, that would be possible nowhere else on earth. A huge bull rhinoceros rushed out of the bush and charged at full speed the so-called "up-mixed" train, which was slowing down as it approached the station Sultan Hamoud, 218 miles from Mombasa. The train was stopped, and the "rhino" was discovered about 100 yards down the track. Slowly he returned to the jungle, and was lost to sight. He did not escape unharmed, for pieces of his thick skin were found adhering to the train, but the fierceness of his assault smashed the engine step and splintered the inch-and-a-half footboard of the first carriage.—Railway and Locomotive Engineering.

Long-span bridges have, of late, not only become more numerous, but their length has been gradually increased, until the long-span bridges of former years are now considered spans of moderate size only. The necessity for the great number of long-span bridges in the United States arose from the fact that many wide navigable rivers had to be bridged where the interests of navigation demanded long spans, or where they were required on account of deep and expensive foundations, or on account of other conditions determining the length of spans. There are now in existence in America about fifty railroad bridges containing simple spans of 400 feet or more, eighteen of which exceed 500 feet, the longest one being the Ohio River Bridge at Louisville, with a span of 546 feet, completed in 1894; there are also a number of highway bridges exceeding 400 feet span. The length of spans practicable for simple trusses has not yet been reached.

The question is often asked whether in case of installing a certain horse-power of boilers, say 300 horse-power, it would be more economical to have three boilers of 100 horse-power each or two boilers of 150 horse-power each. By all means have the two larger units, as it will always be found that the larger boilers have less radiation, less air leakage, and better combustion than a corresponding horse-power in small units. If it is necessary to have a spare unit for cleaning, let there be another one provided of the same size. In regard to the pressure to be carrried, it is well known that a high pressure gives a greater amount of expansion and better economy in proportion to the fuel burned. Even with simple engines in which it is not possible to obtain the full advantage of expansion, the high pressure of steam, which is drier and contains a larger number of heat units in proportion to the volume, gives the best results. Every boiler should be designed for not less than 150 pounds pressure per square inch. Even if it is not possible to utilize the full pressure, the boiler will be stronger, last longer, and be a better investment in the long run.

Of the manufacturing industry to which castor beans give rise in the United States, there is not much to be said. The activities of this industry have for almost a half century been limited to supplying the varying domestic demand for castor oil, for no noteworthy export trade exists and imports are of negligible quantities. The domestic uses of this oil, moreover, important as they are from an economic point of view, are peculiar, in that they absorb only moderate quantities. This is true even in the textile industry. However, there has been an increase, especially in recent years, in the demand in this country for castor oil. Notwithstanding the continuous decline for two decades past in the domestic crop of castor beans, additional capital has occasionally been attracted to the manufacture of this oil, and there has been some expansion in the total productive capacity, especially on the Atlantic coast. In the eighties a mill was erected in Brooklyn, in the nineties another was started in Boston, and within the last few years the manufacture of this oil has been taken up in Memphis, Tenn. But, beyond the mere fact of noting their existence, little significance attaches in this industry to a mere enumeration of mills. The irregularity of operation in some establishments, the long periods of inactivity in others, and a natural reticence among operators to reveal the workings of their plants render it impossible to form any exact idea from productive capacity of the country's actual output of oil. Moreover, except in 1899, no statistics as to the total castor-bean crop have ever been collected. The only factor in the annual supply that is known with exactness is the quantities imported. In recent years that factor has become very important. Instead of Kansas and Oklahoma, the chief source of supply is now the port of New York. In the fiscal year 1902-3 imports of castor beans into the United States amounted to 380,270 bushels, or potentially 760,540 gallons of oil; in 1903-4 the quantity imported amounted to 498,039 bushels, representing in oil 996,078 gallons. The domestic crop of castor beans, though statistically an unknown quantity, is known to have fallen greatly below the 150,000 bushels reported for 1899 by the United States census. Assuming the crop to have been a round 100,000 bushels in 1903, the quantity of castor beans available for manufacture in the year

1903-4 would therefore have been 598,039 bushels, or potentially about 1,200,000 gallons of oil, with a resultant by-product of upward of 10,000 tons of castor pomace. The present most striking characteristic of this industry is its heavy dependence for supplies upon British India.

TRADE NOTES AND FORMULÆ.

Black Shoe Dressing.—3 kilogrammes of paraffine, 1 kilogramme of ceresine, 1 kilogramme of crude wool grease, 0.2 kilogramme of soda lye, 38 deg. Bé., 0.5 kilogramme of nigrosine, solid, fat-soluble, 18 kilogrammes of turpentine oil. Melt the paraffine, ceresine, and wool grease, heat to 120 deg. C., and add the soda lye carefully, a little at a time, stirring well. When the foam has disappeared, cool to 100 deg. C., and dissolve the nigrosine in the mass; at 80 deg. C. add the turpentine oil, and stir until cold. The result will be a smooth cream, which, when it is to be filled into boxes, is warmed over a water-bath to the consistency of a thick liquid.—Der Chemisch-Technische Fabrikant.

Saponified Shoe Dressing Without Turpentine Oil.—0.600 kilogramme of Carnauba wax, 0.150 kilogramme of beeswax, 0.060 kilogramme of ammonia soda, 0.065 kilogramme of tallow grain-soap, 5,500 kilogrammes of water, 0.010 kilogramme of formaline. Melt the Carnauba wax and the beeswax, dissolve the soda, grain-soap, and the color in the water, boiling hot, and add the hot solution in a thin stream, stirring all the time. Continue stirring until cold, and then add the formaline. For colors, use 2 per cent water-soluble aniline dyes, such as nigrosine A R, Bismark brown, chrysaniline yellow, yellow 690, water-soluble, according to the shade desired.—Der Chemisch-Technische Fabrikant.

Saponified Shoe Dressing with Turpentine Oil.—One kilogramme of Carnauba wax, 2 kilogrammes of beeswax, 0.4 kilogramme of potash lye of 40 deg. Bé., 16 kilogrammes of hot water, 6 kilogrammes of turpentine oil. Melt the Carnauba wax and the beeswax at 100 deg. C., stir in the potash lye, and heat until the mass is of uniform consistency. After cooling to 60 deg. C. add the color, which has been previously warmed to 50 deg. C. and dissolved in turpentine, over a water bath. For yellow, use 80 grammes of cerotine yellow; for orange, 60 grammes of cerotine yellow and 30 grammes of cerotine orange; for brown, 60 grammes of cerotine orange and 40 grammes of cerotine brown; for red, 100 grammes of cerotine scarlet, R extra; for black, 1 kilogramme of nigrosine, liquid, and fat-soluble.—Der Chemisch-Technische Fabrikant.

Spice for Fruit Compote.—This is greatly in demand in neighborhoods where many plums and pears are preserved, and is a profitable article in the market. Twenty grammes of the spice are used for one basket of plums.

	Grammes.		Grammes.
Lemon peel	750	or	...
Cinnamon, ordinary	750	or	500
Star anise seed	500	or	150
Coriander	150	or	1,000
Carob pods	250	or	...
Ginger root, peeled	100	or	2,000
Pimento	...	or	1,000
Licorice	...	or	1,000
Cloves, without stems	...	or	300
Spanish peppers	...	or	20
Oil of lemon	...	or	4
Oil of cinnamon	...	or	2
Oil of cloves	...	or	2

All the solid constituents are pulverized, moderately fine, and thoroughly mixed; the oils dropped in last and rubbed into the powder. It is put up in tasteful paper boxes, and marked "Compote Spice," or "Turkish Compote Spice," and sells for about 25 pfennige (about five cents) for 30 grammes.—Der Chemisch-Technische Fabrikant.

The Manufacture of Enamel Varnish.—Enamel varnish, which is coming more and more into use, and is demanded in all colors, is principally used where the cooking of food or the protection of life and health is concerned. Therefore it must have the two properties of being non-poisonous and washable. In order to be washable, it must have a perfectly smooth, hard, and glassy surface, so that the article appears as if lined with porcelain, and this appearance must last as long as possible. Durability depends essentially upon the preparation of the varnish used. The two following formulas have been tested:

I. Ten parts of thick boiled linseed oil are boiled with 1.2 parts of manganese borate. In another kettle, 15.5 parts of ester resin (light) are melted in 14.5 parts of turpentine oil over a moderate fire, and the second solution poured into the first, with stirring; 9 parts of manganese borate varnish are added, 24 parts of zinc white rubbed in, with a little ultramarine.

II. Eight parts of dammar resin are melted in 8 parts of turpentine oil; in another kettle 8 parts of ester resin, dark or light, are melted in 8 parts of turpine oil; the two solutions are poured together, and there are stirred in 5.2 parts of thick boiled linseed oil, unprepared, 8 parts of manganese borate varnish, 16 parts of siccative, and 9 parts of turpentine oil.

This formula is especially suited to dark shades, and no color is to be added. There has been upon the market for some years a porcelain enamel paint containing amyl alcohol, which gives it a somewhat disagreeable odor. To make this, omit in the first formula 4 parts of turpentine oil, in the second 6 parts, and substitute amyl alcohol. Adding amyl acetate gives a far more agreeable odor.—Farben Zeitung.

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